

Daily report

04-06-2020

## Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

## Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓  $\alpha$ : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓  $K$ : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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## **(0) Executive summary – Dashboard**

## Global EU+EFTA+UK trends and needs

We can focus our attention on the **five countries in EU+EFTA+UK that are currently in the best situation: Slovenia, Slovakia, Iceland, Croatia and Greece**. They all have a grade of 1 on the Biocom-Cov scale. **Iceland and Croatia have reported zero daily new cases for a long time**, showing that it is possible to reach this level. Iceland has only 340,000 inhabitants, which makes control easier, but Croatia, with more than 4 million inhabitants, has also achieved this zero-level. Therefore, it shows that large regions and countries could be able to control as well. **Slovakia and Slovenia**, looking at last 7-day average, are only **reporting 1 daily new case by mean**. Slovakia has a population of almost 5.5 million inhabitants, and Slovenia has 2 million, confirming that it is possible to reach really very low levels of active incidence. **Greece**, with more than 10 million inhabitants, is in a similar situation. For about 9 days, they **have reported between 5 and 6 daily new cases on average**. These behaviours should encourage the population of the most affected countries, they show us that achieving a truly exceptional control of the epidemic is possible.

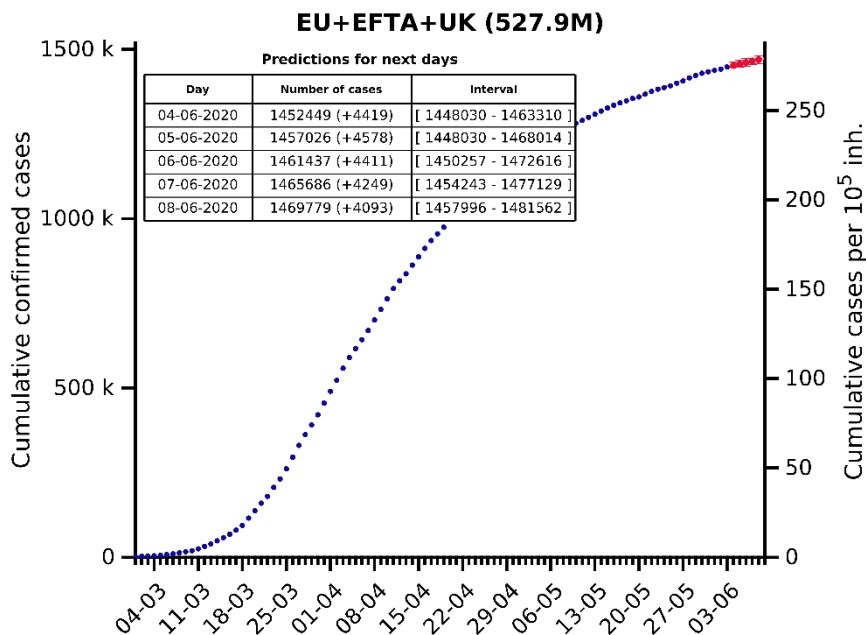
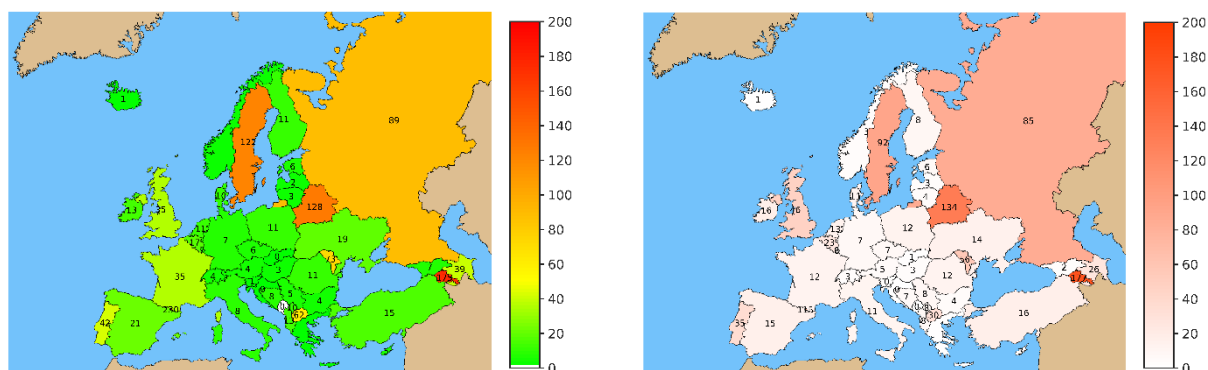
The analysis section presents new data about mobility and confinement in Spain, comparing Facebook and Google indexes.

### Highlights for specific countries

**France** and **Spain's** empiric reproduction numbers ( $\rho_7$ ) are not reliable yet. The decreasing trend of **UK** has stopped at the level of 1,500-2,000 cases for a week. **Sweden** reports a huge spike of more than 2,000 new cases, probably due to a delay or an update in reporting. Therefore, predictions are not reliable.

We have added a new column to the table in the next page, with the epidemiological situation given by the Biocom-Cov degree (see reports #79 and #80 from 1<sup>st</sup> and 2<sup>nd</sup> June).

The map in the left shows current **A<sub>14</sub>**. The map in the right shows current **EPG**.



## Situation and trends per country

Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. Last column (**EPG<sub>EST</sub>**) is assessed with **estimated real 14-day attack rate** (see report from 22/04 for details). **EPG<sub>REP</sub>** is calculated with **data reported by countries**. **EPG<sub>REP</sub>** and **EPG<sub>EST</sub>** **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data								Indexes			
	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$p_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>	Biocom-Cov degree
United Kingdom	279,856	421.2	39,728	59.8	31,563	47.5	445,911	656.9	0.75	36	493	5
Spain	240,326	518.5	27,940	60.3	7,771	16.8	89,975	191.3	1.26	21	241	3
Italy	233,836	393.5	33,601	56.5	6,472	10.9	93,789	155.1	0.79	9	123	2
Germany	182,764	223.1	8,581	10.5	6,012	7.3	29,650	35.4	0.99	7	35	2
France	151,677	234.4	29,021	44.8	7,832	12.1	155,768	238.6	2.91	35	695	3
Belgium	58,685	516.7	9,522	83.8	2,702	23.8	44,150	380.9	0.73	17	279	3
Netherlands	46,733	275.1	5,977	35.2	2,286	13.5	29,245	170.7	0.82	11	141	3
Sweden	40,803	414.7	4,542	46.2	9,280	94.3	115,724	1,145.9	1.33	126	1,527	7
Portugal	33,261	320.7	1,447	14.0	3,601	34.7	16,585	162.7	1.19	41	194	5
Switzerland	30,810	359.5	1,659	19.4	235	2.7	1,282	14.8	1.30	4	19	2
Ireland	25,111	531.3	1,659	35.1	796	16.8	5,265	106.6	0.81	14	87	3
Poland	24,395	63.8	1,092	2.9	4,656	12.2	21,994	58.1	0.85	10	50	3
Romania	19,669	99.4	1,288	6.5	2,282	11.5	15,658	81.4	0.90	10	73	3
Austria	16,705	191.7	670	7.7	430	4.9	1,739	19.3	0.84	4	16	2
Denmark	11,771	206.1	580	10.2	654	11.4	3,286	56.7	0.87	10	49	3
Czech Republic	9,438	88.9	324	3.1	717	6.8	2,656	24.8	0.86	6	21	2
Norway	8,446	157.3	237	4.4	178	3.3	506	9.3	0.66	2	6	2
Finland	6,911	125.6	321	5.8	468	8.5	2,281	41.2	1.24	11	51	2
Luxembourg	4,020	697.9	110	19.1	49	8.5	141	22.5	0.95	8	21	2
Hungary	3,931	40.3	534	5.5	290	3.0	4,113	42.6	0.89	3	38	2
Greece	2,937	26.3	179	1.6	87	0.8	541	5.2	0.75	1	4	1
Bulgaria	2,585	36.3	147	2.1	254	3.6	1,509	21.7	0.97	3	21	2
Croatia	2,246	53.3	103	2.4	12	0.3	53	1.3	0.61	0	1	1
Estonia	1,880	143.3	69	5.3	86	6.6	NA	NA	0.89	6	NA	2
Iceland	1,806	495.8	10	2.7	3	0.8	NA	NA	0.71	1	NA	1
Lithuania	1,684	57.9	71	2.4	107	3.7	NA	NA	0.65	2	NA	2
Slovakia	1,525	28.0	28	0.5	29	0.5	NA	NA	0.57	0	NA	1
Slovenia	1,477	71.1	108	5.2	9	0.4	67	3.2	1.79	1	6	1
Latvia	1,079	54.7	24	1.2	63	3.2	NA	NA	0.73	2	NA	2
Cyprus	958	81.9	17	1.5	36	3.1	NA	NA	1.55	5	NA	2
Malta	622	145.0	9	2.1	38	8.9	NA	NA	NA	NA	NA	2
Liechtenstein	83	215.3	1	2.6	0	0.0	NA	NA	NA	NA	NA	2

Scale											
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	100	1000
Best	Best	Best	Best	Best	Best	Best	Best	Best	0.0	0	0

**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher)

<sup>(1)</sup>  $p_7$  is the average of 7 consecutive  $p$ , but can still fluctuate. <sup>(2,3)</sup> EPG stands for Effective Growth Potential. EPG<sub>REP</sub> is the product of attack-rate of last 14 days per 10<sup>5</sup> inhabitants by  $p_7$  (empiric reproduction number). EPG<sub>EST</sub> is the product of estimated real attack-rate of last 14 days per 10<sup>5</sup> inhabitants and  $p_7$ . Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (<https://upcommons.upc.edu/handle/2117/189661>, <https://upcommons.upc.edu/handle/2117/189808>).

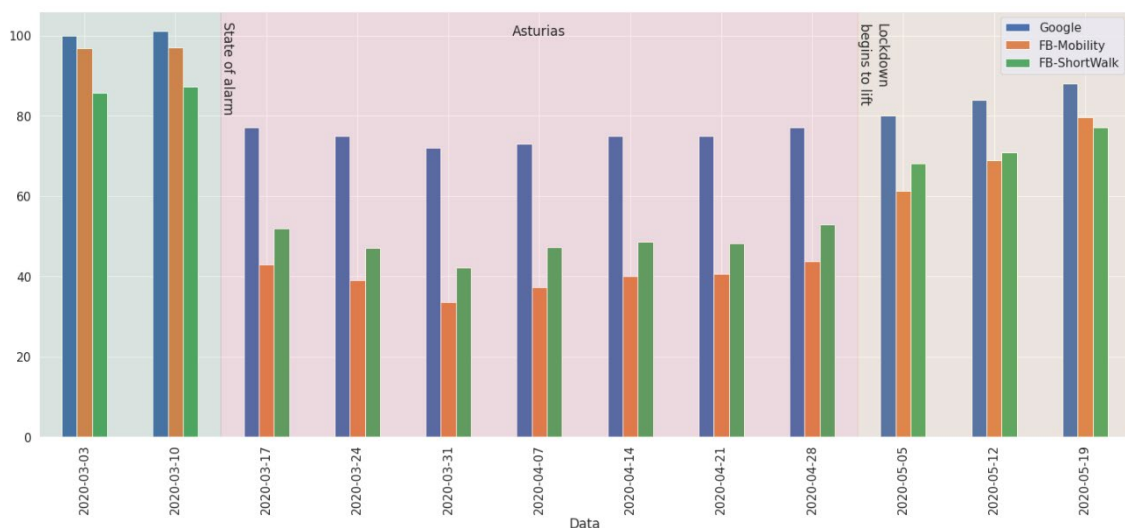
## Analysis: Mobility and confinement in Spain. Using different indexes to assess the gradual opening of the economy.

Last week (Report #75<sup>(1)</sup>) we assessed how the two main cities of Spain were reopening the economy and how the mobility has returned to 70% pre-curfew levels.

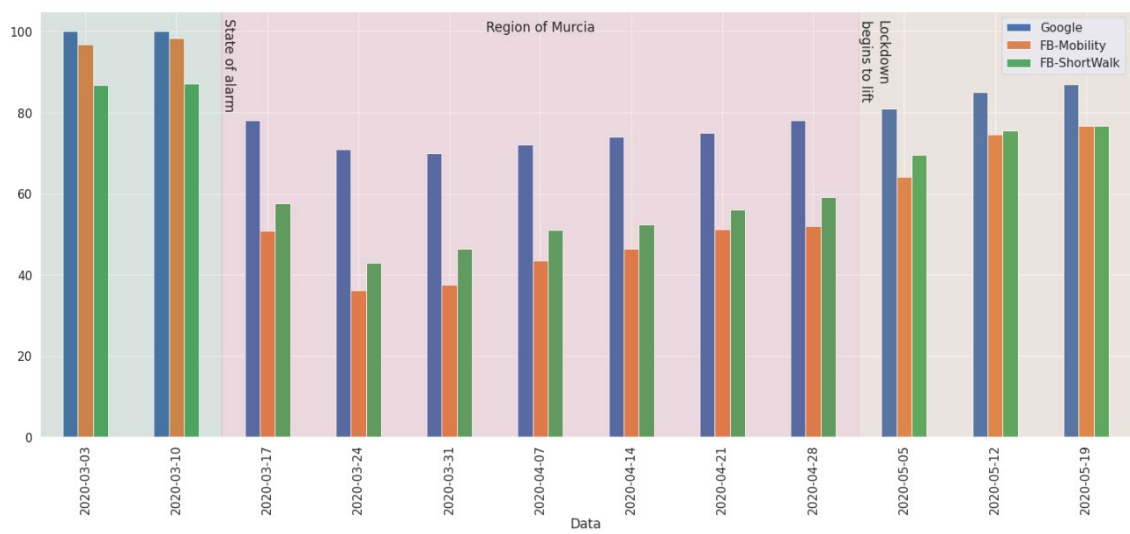
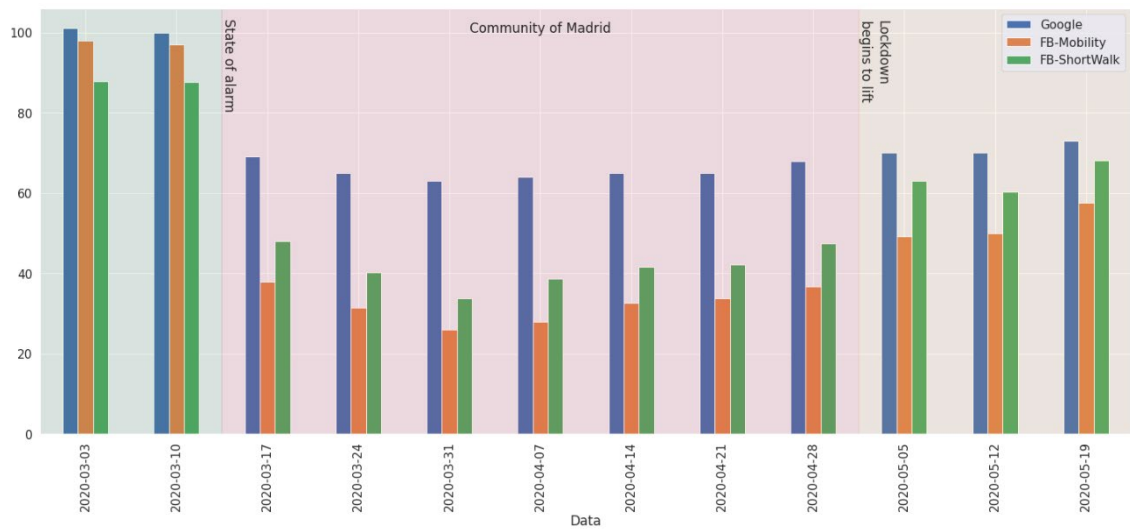
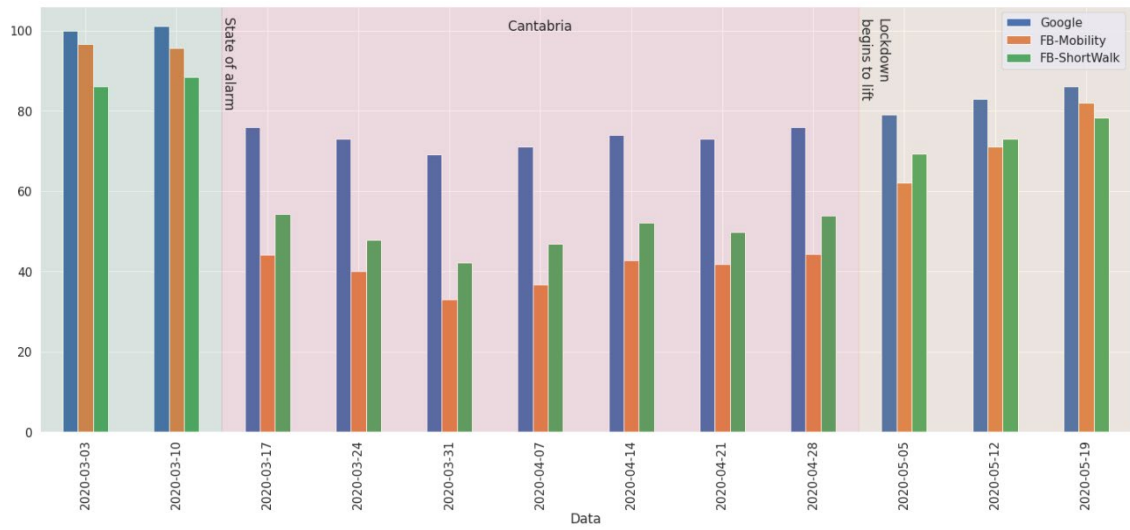
We have also discussed that **Facebook Data for Good (FB)** tracks **people remaining at home** (FB short walk index) and also the **number of different places that not-confined people visit compared with a pre-curfew baseline** (FB mobility index). Besides, **Google** data residential index indicates **what is the increase in time that people remain in their residential areas**. FB data are provided at the province level, while Google data are released at the regional level (Autonomous Community). We noticed also that different days of the week have different relations between FB and Google indexes. In this sense, Tuesday is a very good representation of a typical working day, where all indexes are strongly correlated and systematically point in the same direction.

However, we notice today that **they provide very interesting complementary information**. In this sense we focus today on four Autonomous Communities in Spain which also have only one province: Madrid, Murcia, Cantabria and Asturias. This allows us to compare the three indexes since directly without any processing on our part.

The next figures show the evolution of the three indexes in each area for all Tuesdays along since the beginning of March. Note that all indexes are represented in such a way that a high value represents higher mobility and deconfinement, while low values correspond to lower mobility and higher confinement (i.e., lower deconfinement).



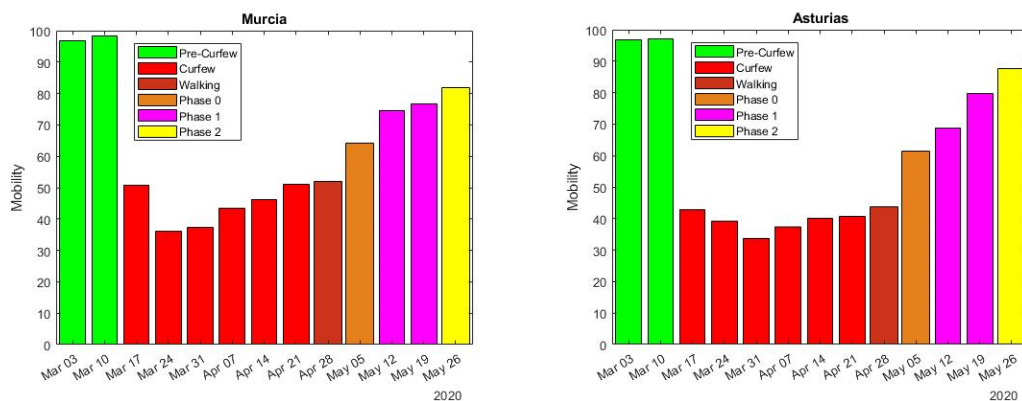
<sup>1</sup> <https://upcommons.upc.edu/handle/2117/189416>



From the figures, we can draw three important conclusions:

- Although, in principle, everyone has the right to leave home, the percentage of people who stay home throughout the day is about twice what it was before the epidemic began. If in Spain, **typically, 10% of the population on any given day stays at home**, either for reasons of lack of mobility or simply for rest or leisure, **at this time this value has consistently doubled**.
- Google data also seems to indicate that we stay longer at home, not just those who stay permanently, but in general. In the early stages of confinement, the increase in time spent at home by 20-30% (average time to sleep in Spain 7h, TV time 4h, so outside normal hours): it would be 40-60% during the day. Even now in phase 2 there is a 50% increase at home in Madrid and 20% in Murcia (double that during the day compared to the previous time).
- This increase in departures due to work and leisure has meant that the mobility aggregate according to FB has gone from being approximately 1/3 of the usual during the state of alarm and now 70% of the usual in Madrid, 80% Murcia and 90% in Asturias.

We focus now on this last point, regarding the mobility index, indicating the different phases of the curfew. We see in a previous report (Report #75<sup>(2)</sup>), where we also detailed the deconfinement phases in Spain, that Madrid is in a lower level of the opening and has less mobility. However, it is interesting to observe the differences between Murcia and Asturias. In both cases, when curfew was imposed both had the mobility reduced at roughly the same level, but now Asturias has recovered more than Murcia. It seems reasonable to expect that different regions will recover mobility differently given the input regarding the seriousness of the situation and the same structure of the behaviour.



In any case, we should not be surprised that some areas in phase 2 are actually behaving in terms of mobility very close to normal. It is thus very important to track these areas and see if we can detect any increase in the number of cases compared with other areas.

<sup>2</sup> <https://upcommons.upc.edu/handle/2117/189416>

## Situation and trends in other countries

**Table** of current situation in a sample of non-EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. EPG<sub>REP</sub> and EPG<sub>EST</sub> **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

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	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>	Biocom-Cov degree
United States of America	1.851.520	559,4	107.175	32,4	299.667	90,5	1.833.157	553,8	1,04	94	575	7
Brazil	584.016	274,8	32.548	15,3	292.437	137,6	1.933.407	909,6	1,33	184	1.213	8
Russia	432.277	296,2	5.215	3,6	123.572	84,7	NA	NA	1,05	89	NA	7
India	216.919	16,0	6.075	0,4	104.560	7,7	347.944	25,7	1,18	9	30	3
Peru	178.914	542,6	4.894	14,8	74.894	227,1	235.279	713,6	1,34	304	954	9
Iran	160.696	191,3	8.012	9,5	33.747	40,2	181.264	215,8	1,22	49	264	5
Chile	113.628	594,4	1.275	6,7	60.011	313,9	142.460	745,2	1,07	337	800	9
Mexico	101.238	78,5	11.728	9,1	44.644	34,6	640.788	497,0	1,05	36	521	5
Canada	93.074	246,6	7.498	19,9	12.983	34,4	115.809	306,8	0,80	28	247	4
Saudi Arabia	91.182	261,9	579	1,7	28.637	82,3	NA	NA	0,85	70	NA	6
Pakistan	85.264	38,6	1.770	0,8	37.173	16,8	94.277	42,7	1,60	27	68	4
Qatar	62.160	2.157,5	45	1,6	25.063	869,9	NA	NA	1,08	939	NA	9
Belarus	45.116	477,5	248	2,6	12.690	134,3	NA	NA	0,96	128	NA	7
Ecuador	40.966	232,2	3.486	19,8	6.112	34,6	60.211	341,3	0,97	33	329	5
Argentina	19.255	42,6	583	1,3	9.985	22,1	45.767	101,3	1,07	24	109	4

Scale											
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	100	1000
Best	Best	Best	Best	Best	Best	Best	Best	Best	0,0	0	0

**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

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## Time indicators by country

These tables summarize a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of  $1/10^5$  inhabitants and an attack rate of  $10/10^5$  inhabitants, and time interval between attack rates of 10 to 100 per  $10^5$  inhabitants (only for countries that have overtaken this threshold).

### EU+EFTA+UK countries

Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / $10^5$ inh. (days)	Time interval between 10 and 100 cases / $10^5$ inh. (days)
Italy	102	11	16
Germany	96	12	17
France	95	10	20
Spain	95	8	12
United Kingdom	91	10	12
Belgium	90	11	14
Netherlands	90	11	20
Sweden	90	10	28
Norway	90	2	7
Switzerland	90	8	11
Austria	88	10	14
Denmark	87	4	30
Czech Republic	84	11	NA
Finland	84	12	46
Greece	84	18	NA
Iceland	84	5	15
Portugal	83	9	15
Slovenia	83	6	NA
Estonia	82	5	30
Ireland	82	8	18
Poland	82	17	NA
Romania	82	15	NA
Luxembourg	79	6	7
Slovakia	78	24	NA
Bulgaria	77	30	NA
Croatia	77	12	NA
Hungary	76	20	NA
Latvia	76	12	NA
Lithuania	75	9	NA
Malta	74	9	35
Cyprus	73	12	NA

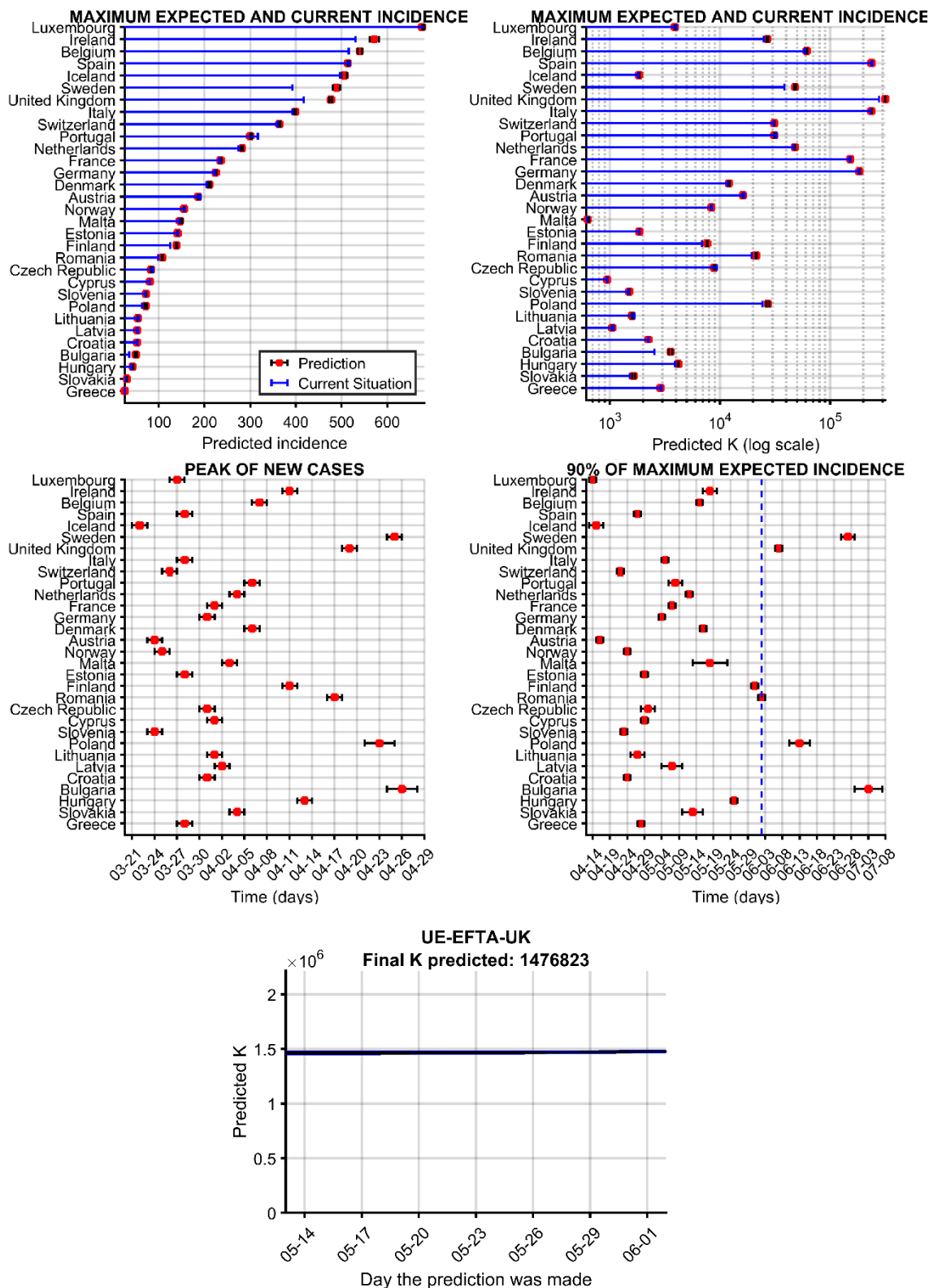


## Other countries

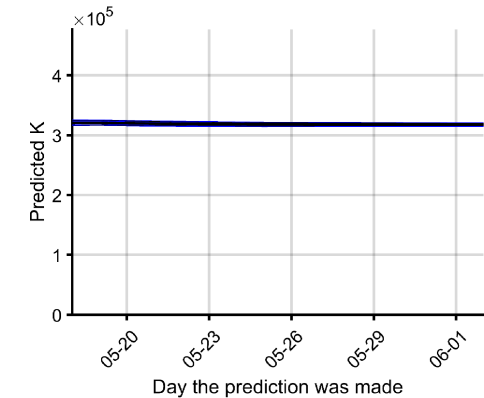
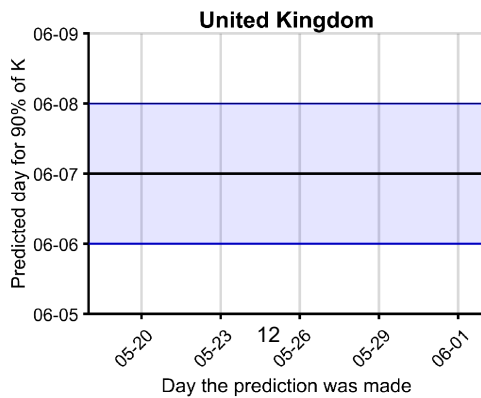
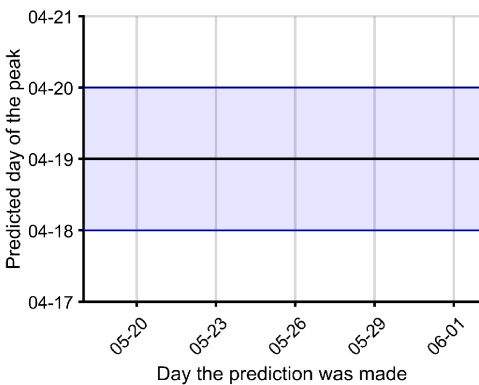
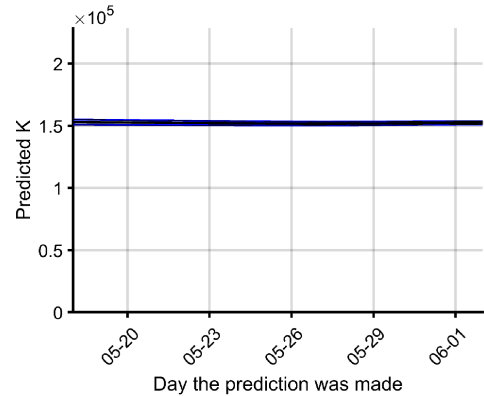
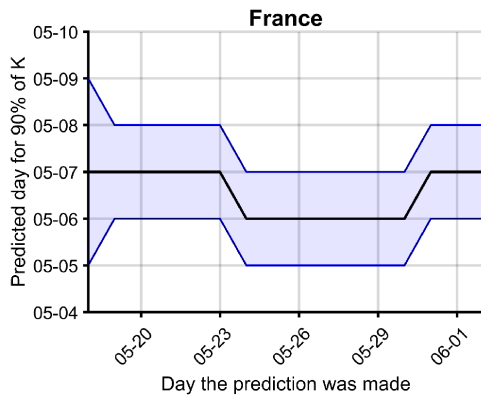
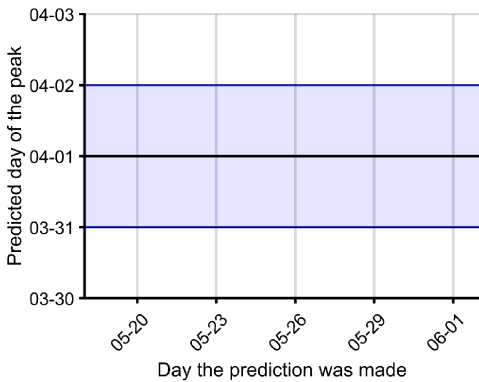
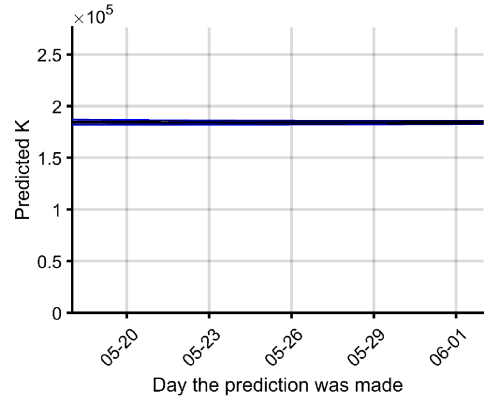
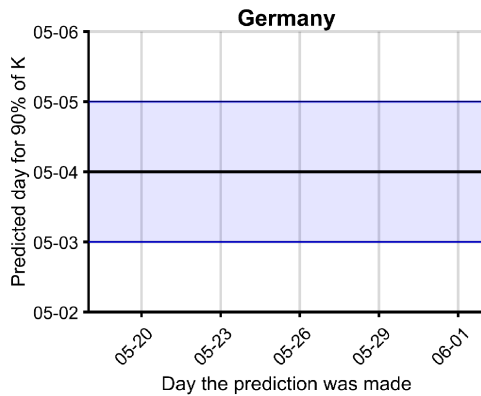
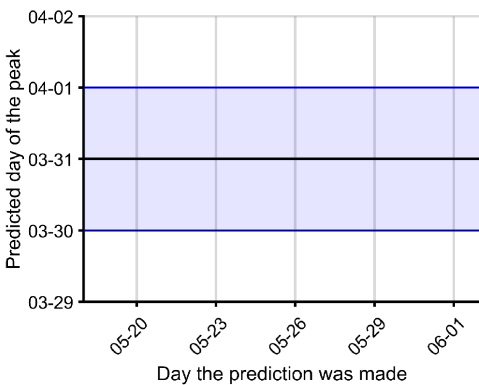
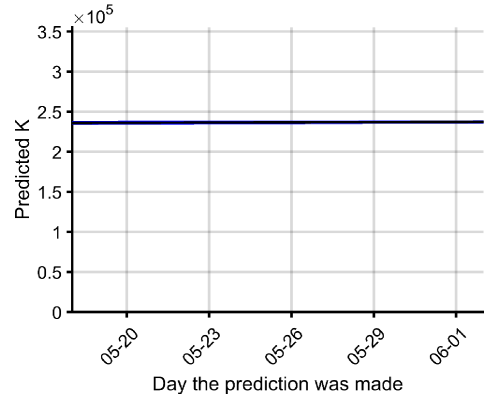
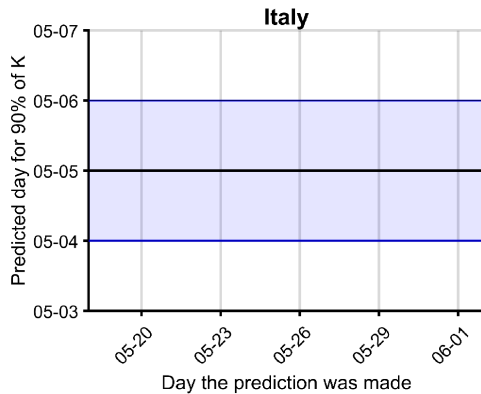
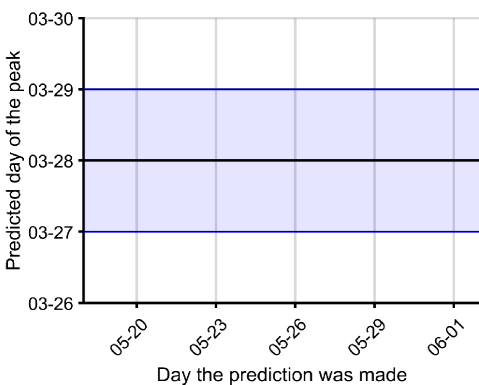
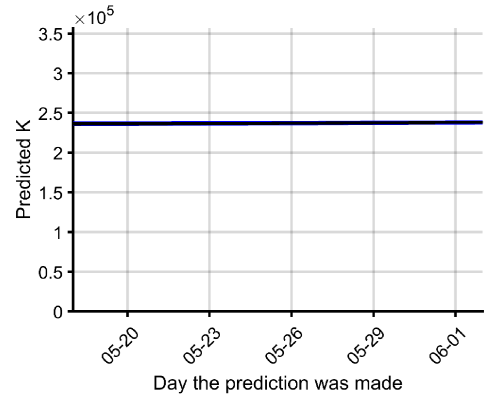
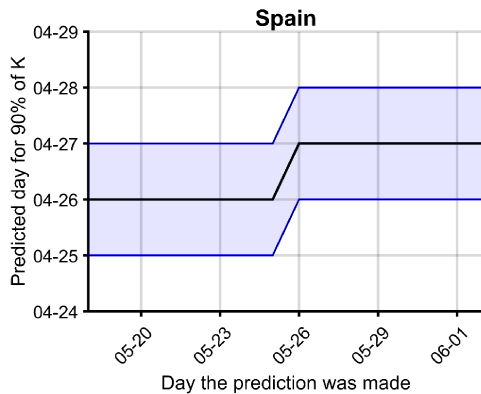
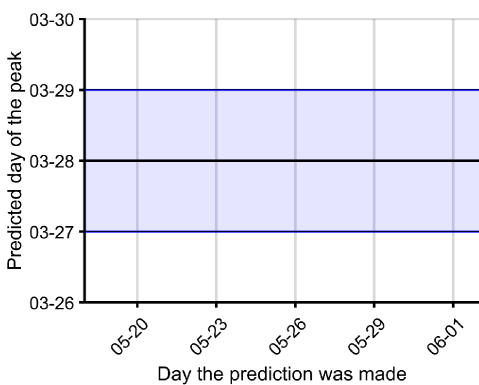
Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / $10^5$ inh. (days)	Time interval between 10 and 100 cases / $10^5$ inh. (days)
Iran	99	11	42
United States of America	94	8	15
Canada	85	11	27
Qatar	85	3	31
Brazil	82	20	34
Saudi Arabia	81	21	29
Chile	80	13	36
Pakistan	80	35	NA
India	80	38	NA
Russia	79	15	24
Peru	79	18	22
Ecuador	79	10	30
Mexico	78	25	NA
Argentina	77	39	NA
Belarus	66	10	18

## Long-term predictions

Evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per  $10^5$  inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date. At the end, predicted K for whole EU+EFTA+UK.



2020-06-02



## Situation and trends in Italian regions<sup>3</sup>

### Situation and trends

Country	Reported data								Indexes			
	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>	Biocom-Cov degree
Lombardia	89,526	891,5	16,201	161,3	3,435	34,2	62,455	620,8	0,81	28	501	4
Piemonte	30,758	706,0	3,910	89,8	768	17,6	9,999	229,5	0,82	15	189	3
Emilia Romagna	27,860	624,7	4,154	93,1	443	9,9	6,638	148,9	0,77	8	114	2
Veneto	19,168	390,7	1,934	39,4	130	2,6	1,306	26,6	0,62	2	17	1
Toscana	10,122	271,4	1,059	28,4	122	3,3	1,238	33,2	0,75	2	25	2
Liguria	9,772	630,2	1,479	95,4	428	27,6	6,577	424,1	0,77	21	325	4
Lazio	7,764	132,1	750	12,8	206	3,5	2,037	34,6	0,64	2	22	2
Marche	6,738	441,8	988	64,8	49	3,2	733	48,1	1,04	3	50	2
Campania	4,822	83,1	420	7,2	99	1,7	860	14,8	0,84	1	13	1
Puglia	4,503	111,8	514	12,8	90	2,2	970	24,1	0,50	1	12	1
Trento	4,433	413,4	464	43,3	55	5,1	579	107,6	0,27	1	29	2
Sicilia	3,447	68,9	276	5,5	30	0,6	251	5,0	0,72	0	4	1
Friuli Venezia Giulia	3,279	269,8	336	27,6	64	5,3	644	53,0	0,53	3	28	2
Abruzzo	3,255	248,2	415	31,6	43	3,3	556	42,4	1,40	5	59	2
Bolzano	2,598	2,418,2	292	271,8	11	10,2	115	22,0	0,93	10	20	1
Umbria	1,431	162,2	76	8,6	2	0,2	NA	NA	0,00	0	NA	2
Sardegna	1,357	82,8	131	8,0	1	0,1	13	0,8	0,21	0	0	1
Valle d'Aosta	1,187	945,0	143	113,8	11	8,8	133	105,4	1,14	10	120	3
Calabria	1,158	59,5	97	5,0	2	0,1	NA	NA	0,14	0	NA	1
Molise	436	142,7	23	7,5	13	4,3	NA	NA	0,25	1	NA	2
Basilicata	399	70,9	27	4,8	5	0,9	NA	NA	0,00	0	NA	2

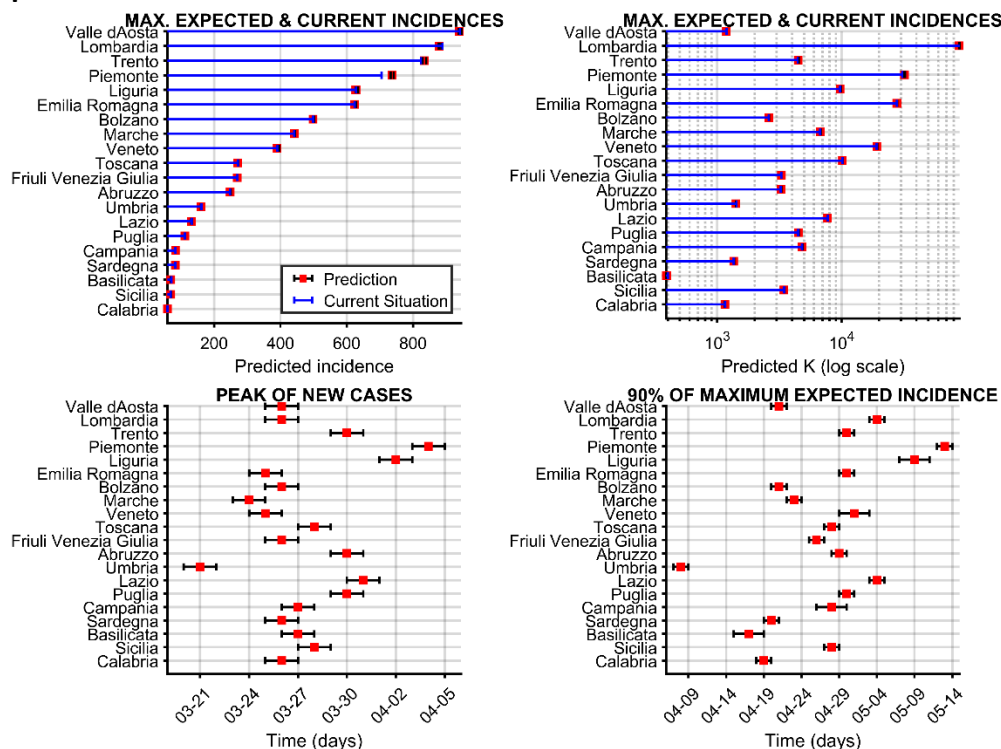
  

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst
Best	Best	Best	Best	Best	Best	Best	Best	Best	Best

**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

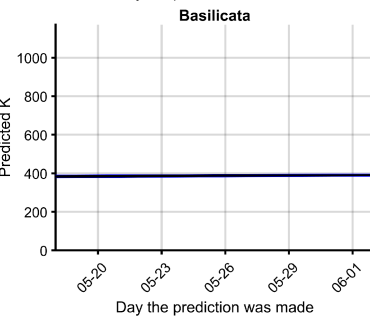
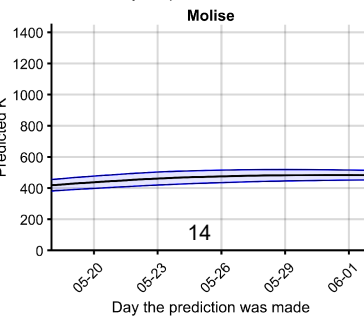
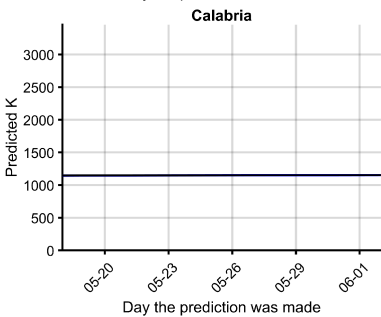
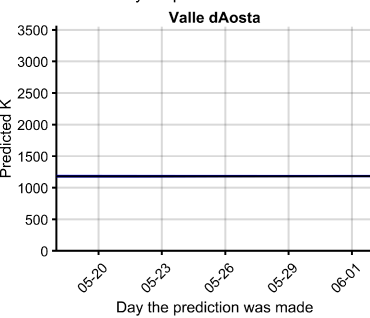
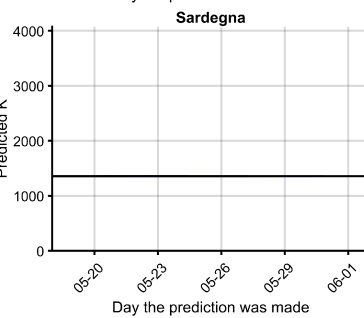
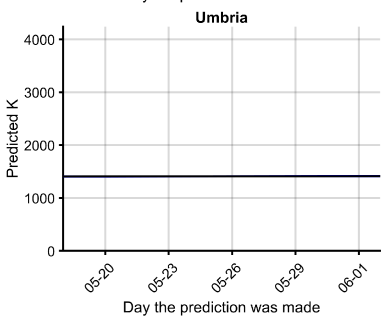
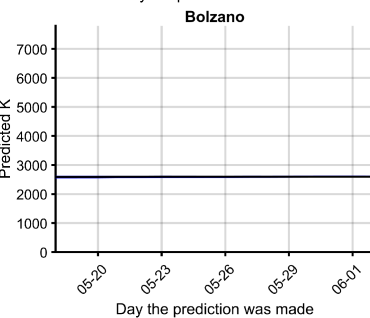
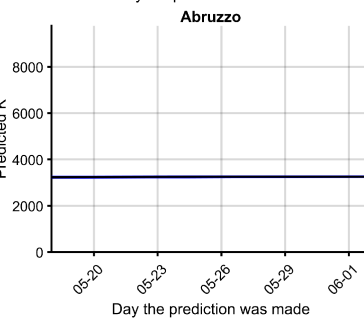
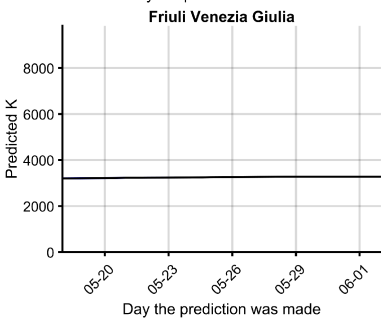
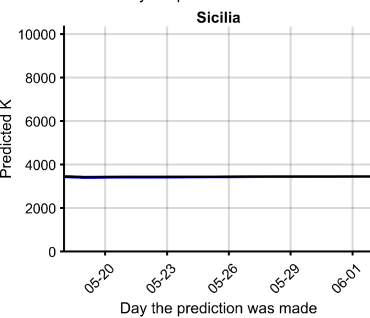
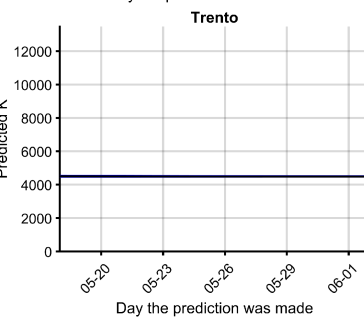
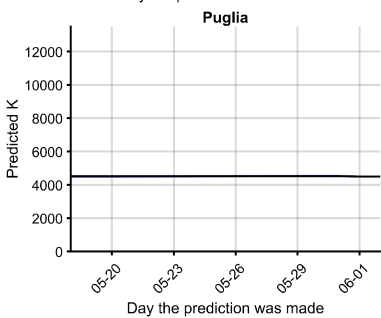
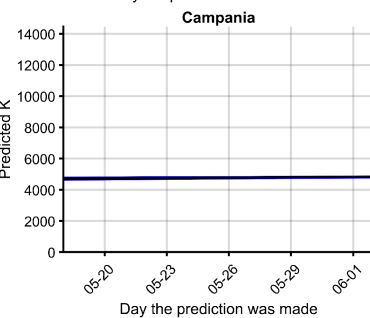
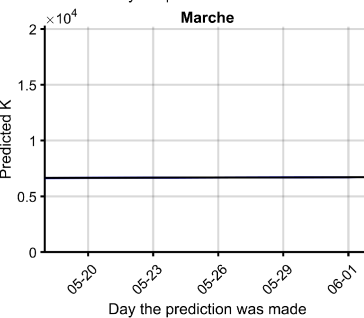
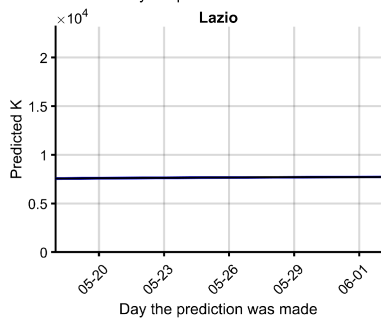
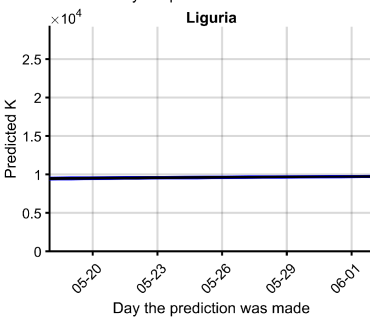
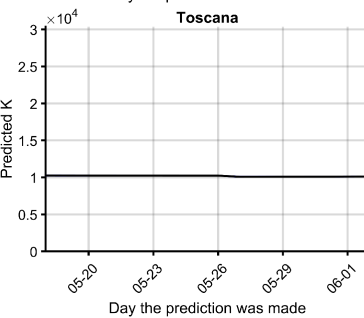
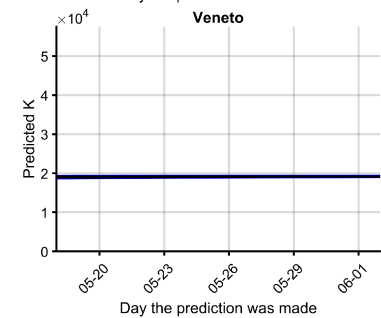
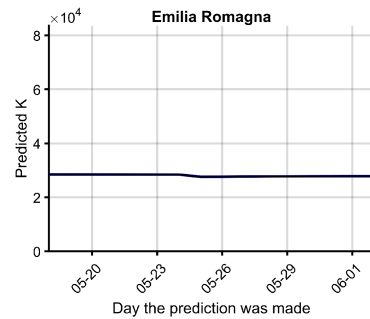
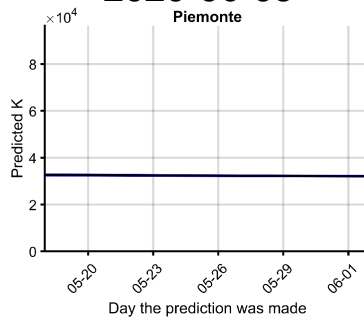
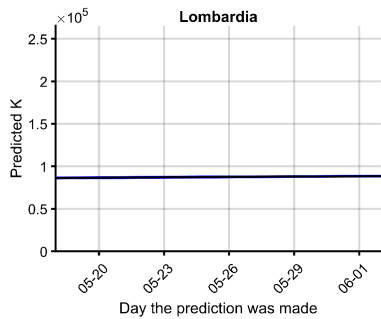
<sup>(1)</sup>  $\rho_7$  is the average of 7 consecutive  $\rho$ , but can still fluctuate. <sup>(2,3)</sup> EPG stands for Effective Growth Potential. EPG<sub>REP</sub> is the product of attack-rate of last 14 days per 10<sup>5</sup> inhabitants by  $\rho_7$  (empiric reproduction number). EPG<sub>EST</sub> is the product of estimated real attack-rate of last 14 days per 10<sup>5</sup> inhabitants and  $\rho_7$ . Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (<https://upcommons.upc.edu/handle/2117/189661>, <https://upcommons.upc.edu/handle/2117/189808>).

### Long-term predictions



<sup>3</sup> Spain: Historical series have not been updated. Therefore, regional analysis is not shown

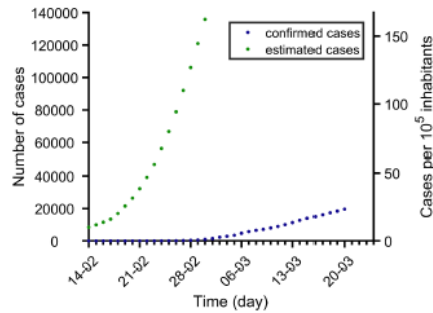
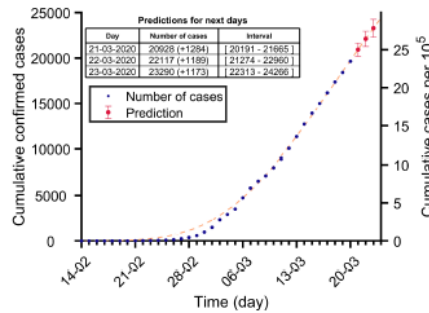
2020-06-03



## Legend: Countries' reports details

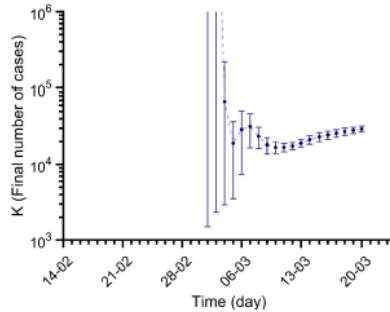
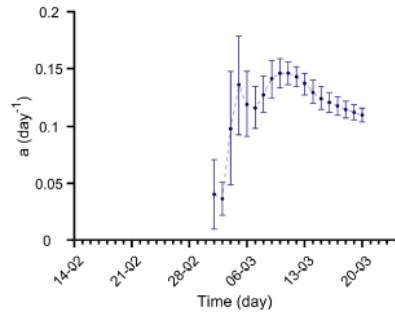
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence:  $23/10^5$

Confirmed cases:  
data (blue),  
model fitted  
(dashed line),  
predictions (red  
points and table)



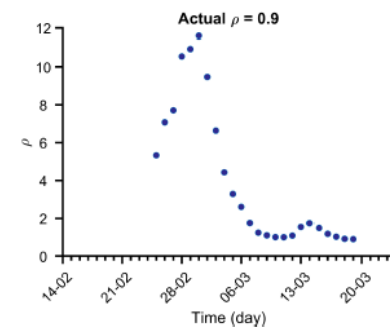
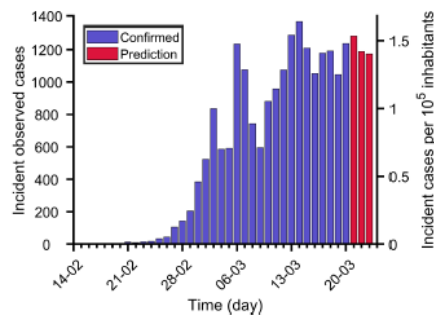
Estimated  
cases using  
death rate (see  
Methods)

Fitted  $a$  value  
using points  
prior to each  
date



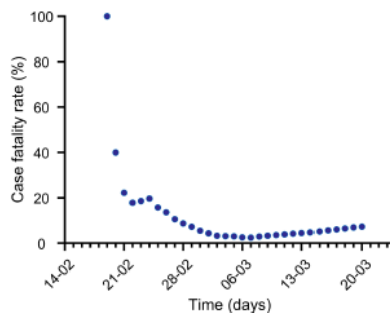
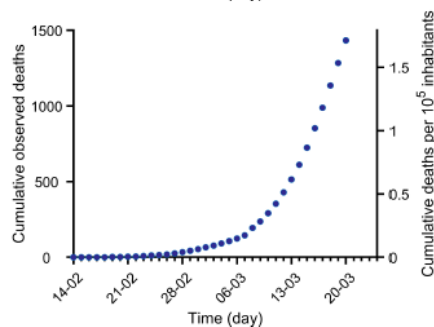
Fitted  $K$  value  
using points  
prior to each  
date

Reported  
and  
predicted  
new cases



Evolution of  $\rho$ , a  
parameter related  
with Reproduction  
number (see  
Methods)

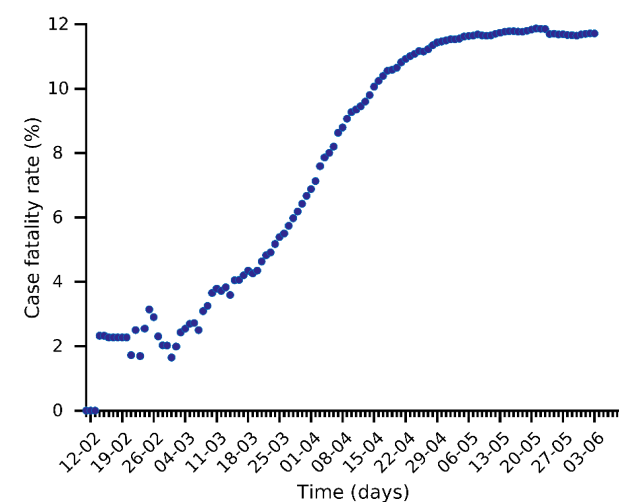
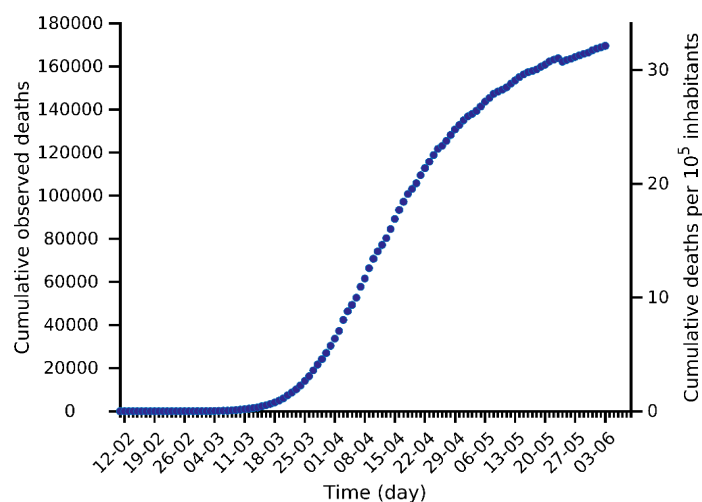
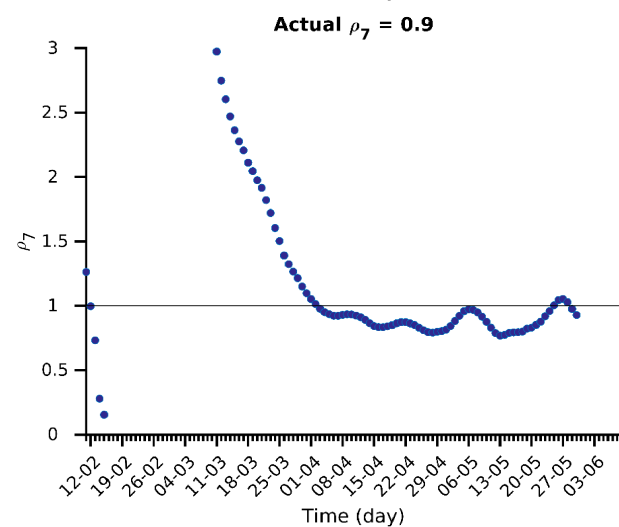
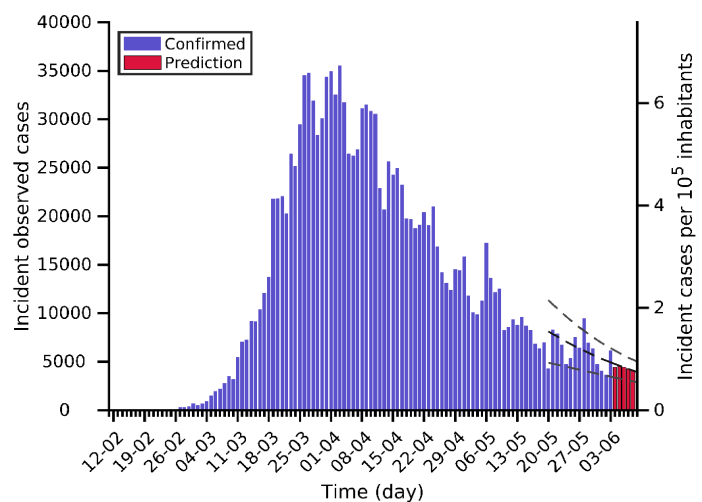
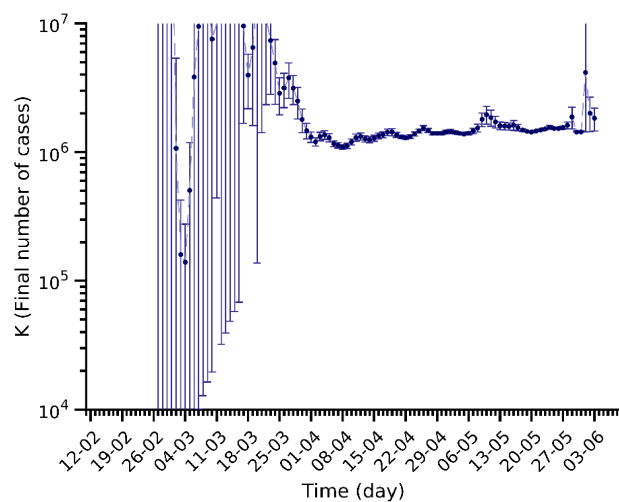
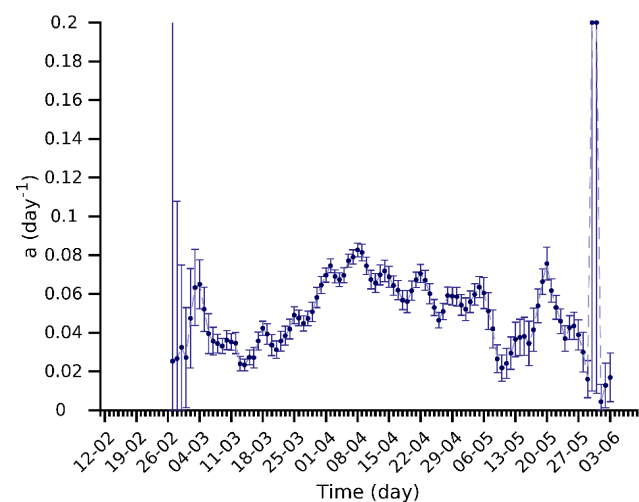
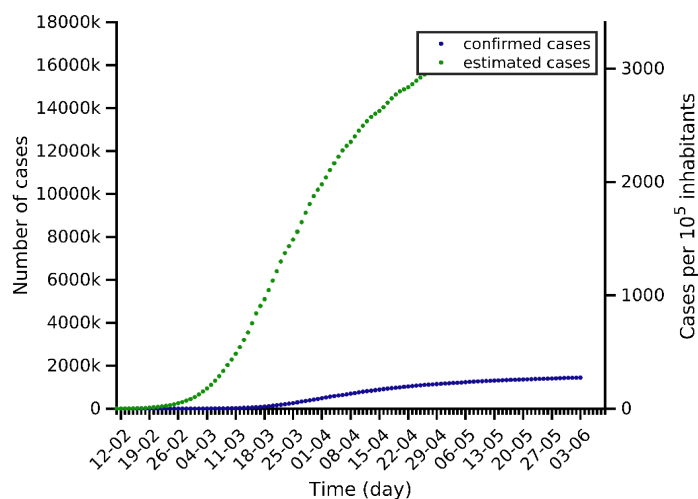
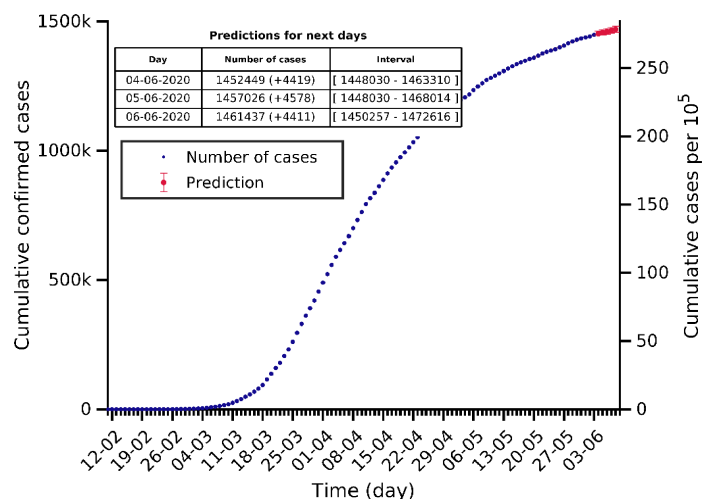
Reported  
deaths



Deaths /  
cumulated  
reported cases

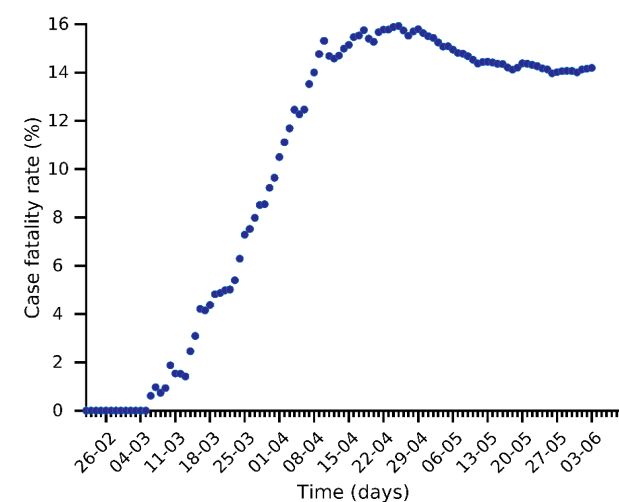
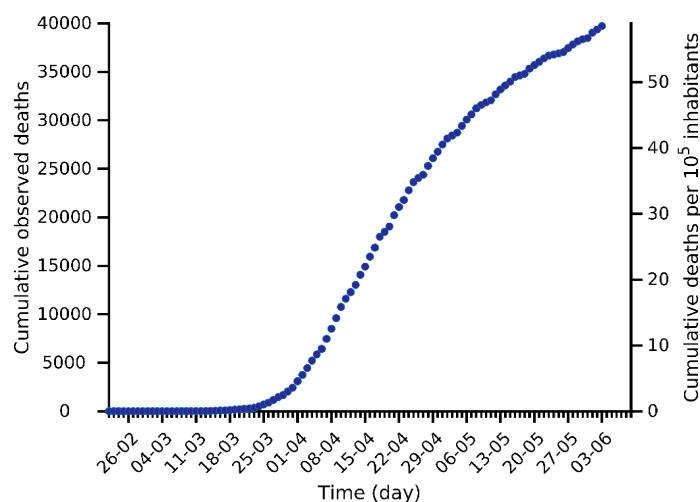
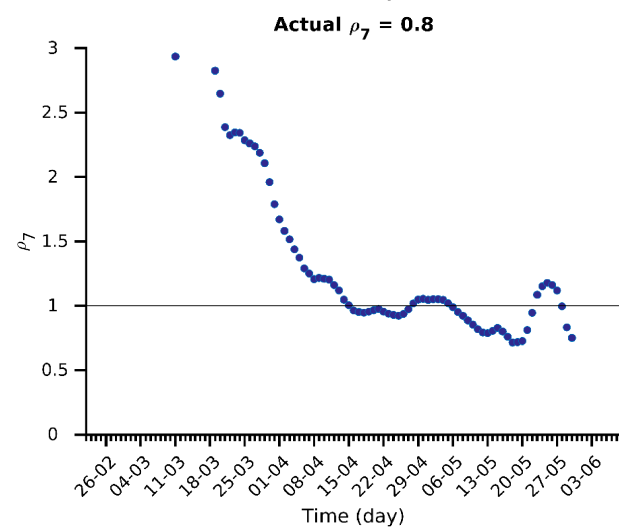
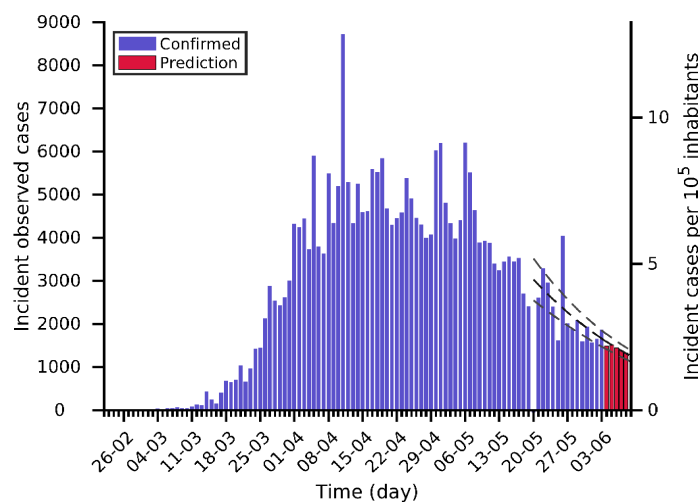
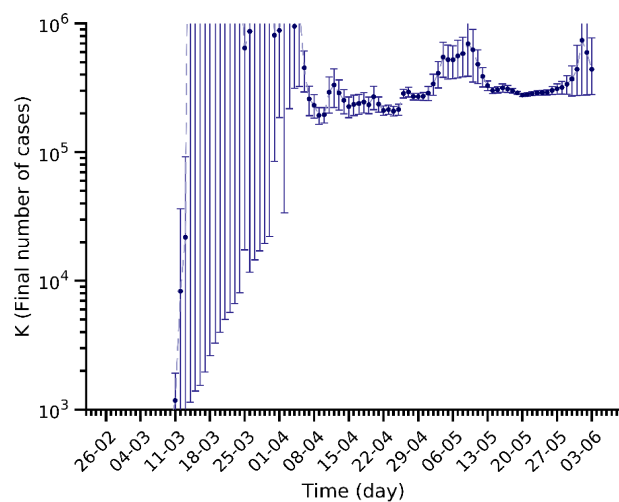
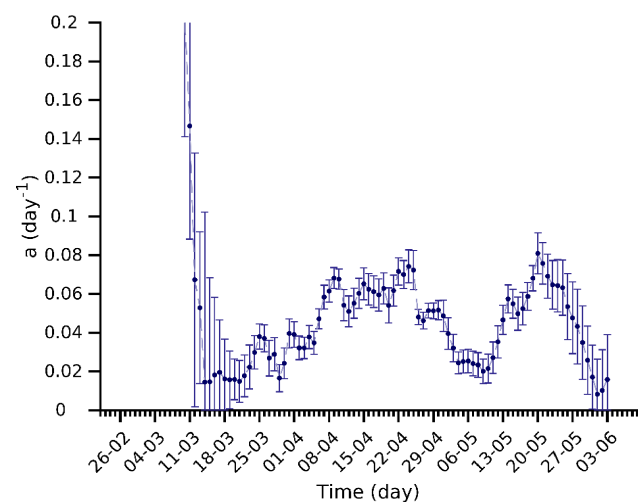
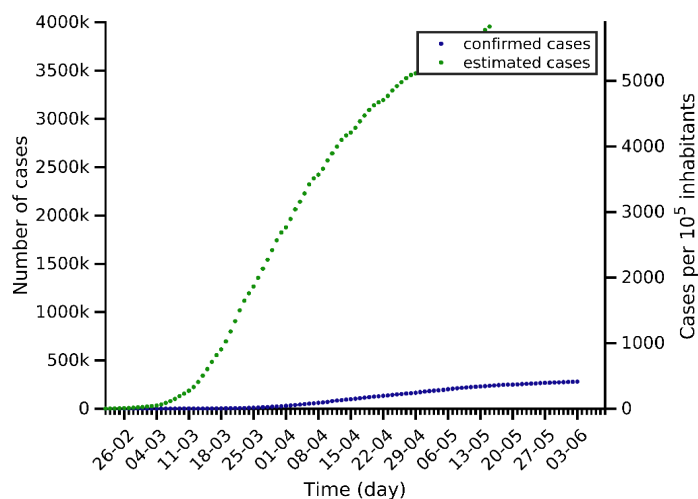
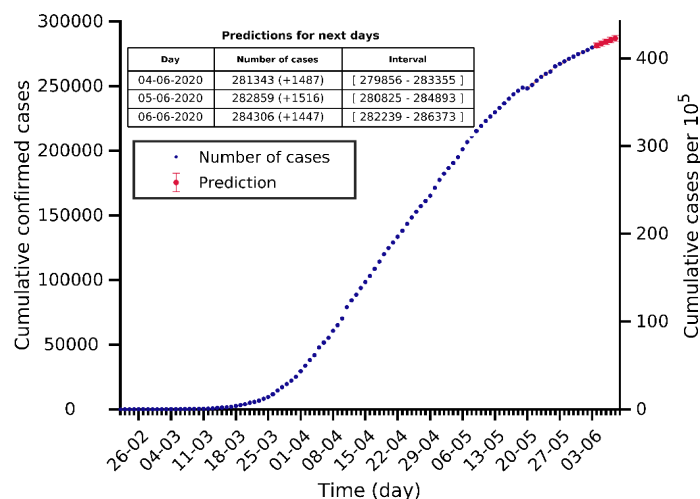
## **(1) Analysis and prediction of COVID-19 for EU+EFTA+UK**

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

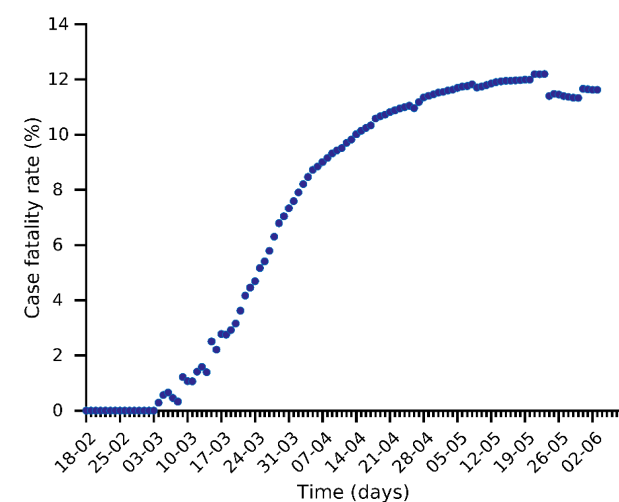
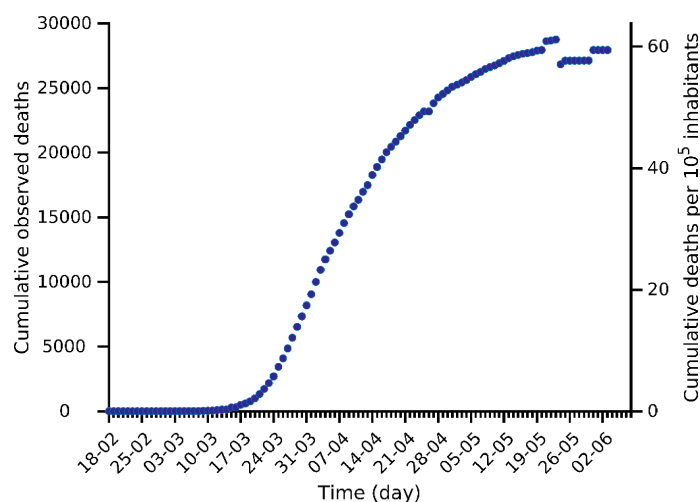
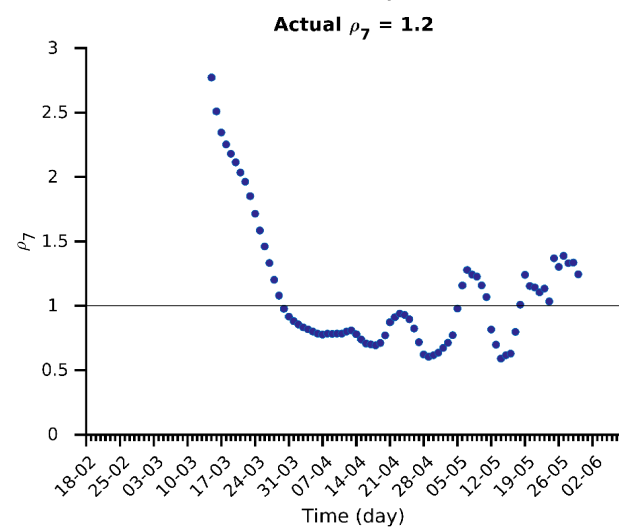
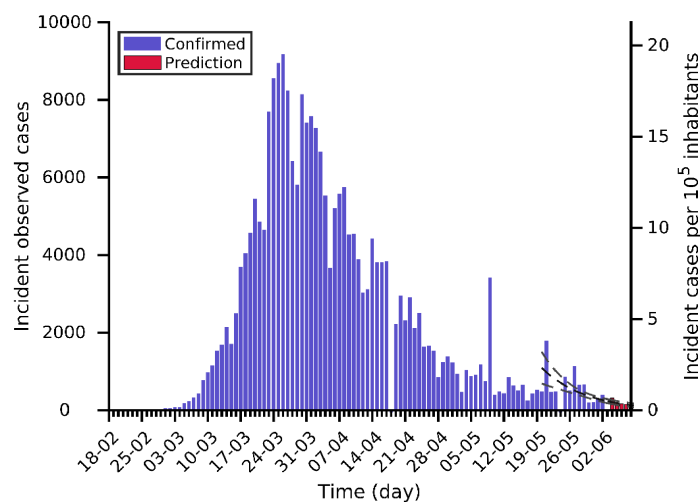
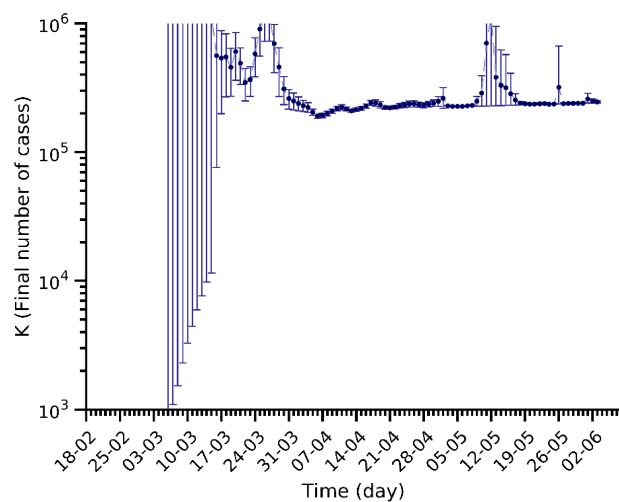
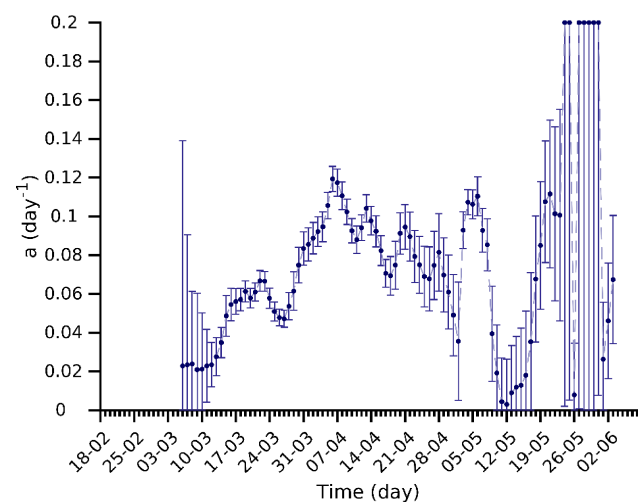
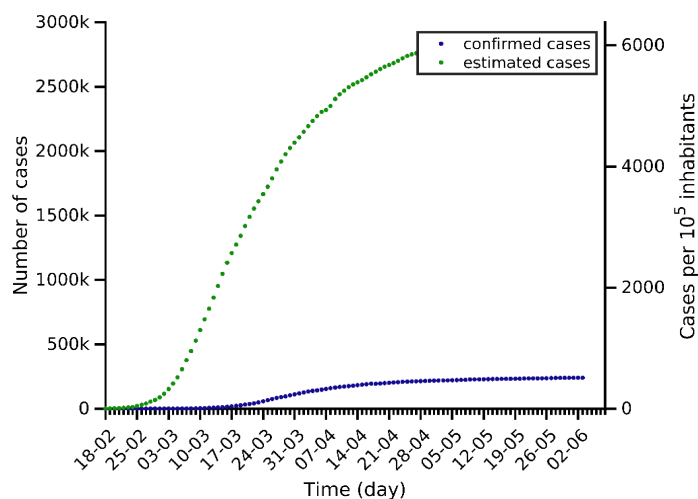
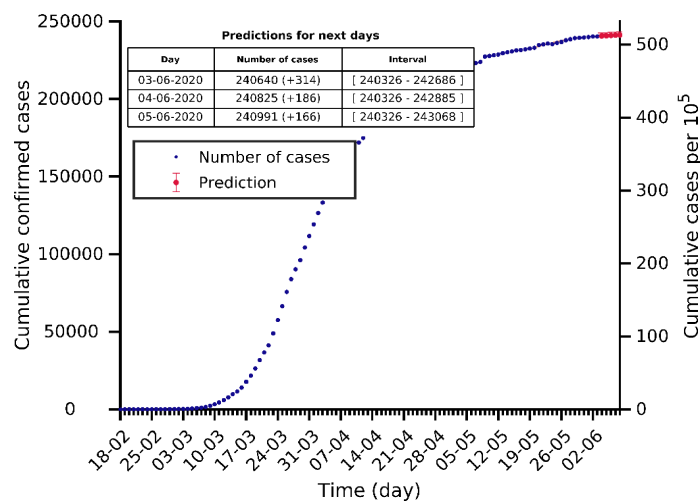




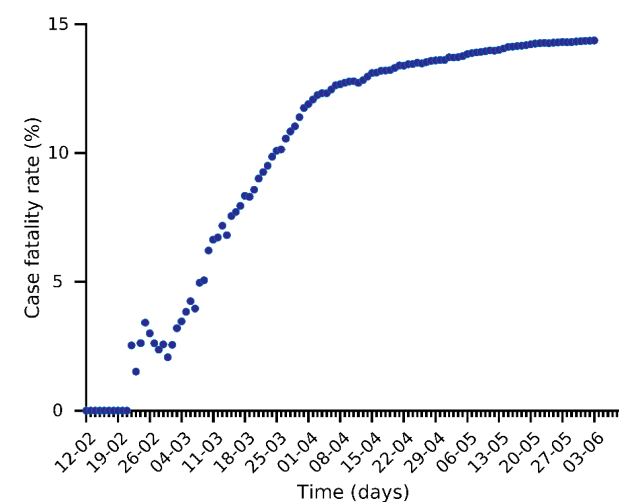
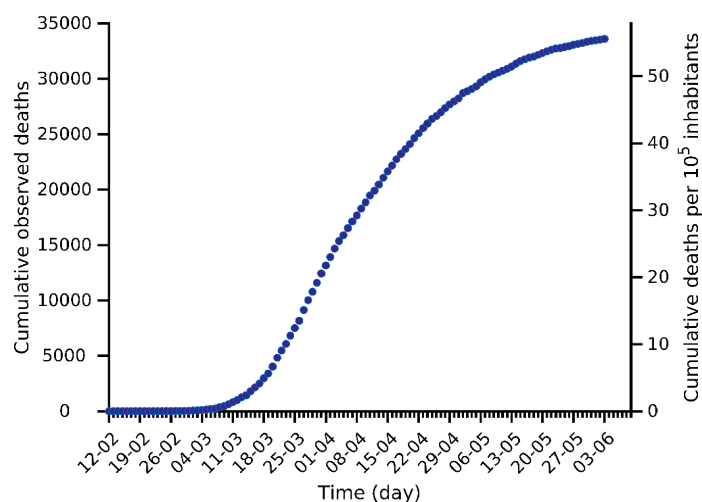
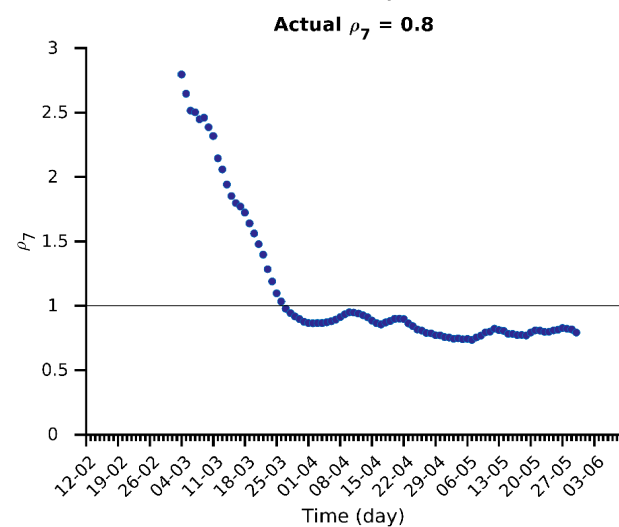
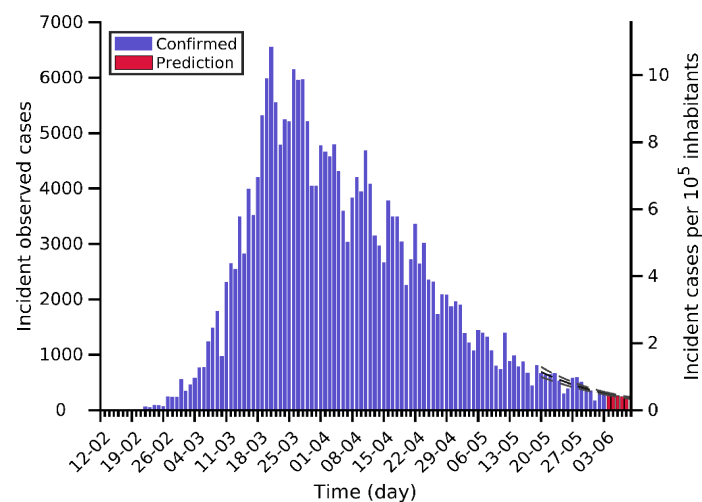
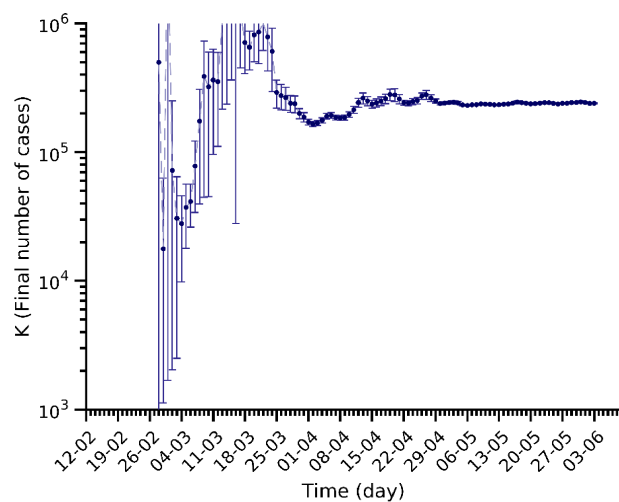
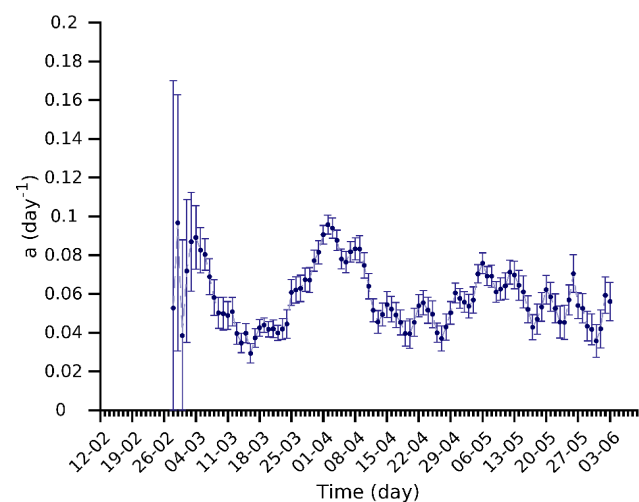
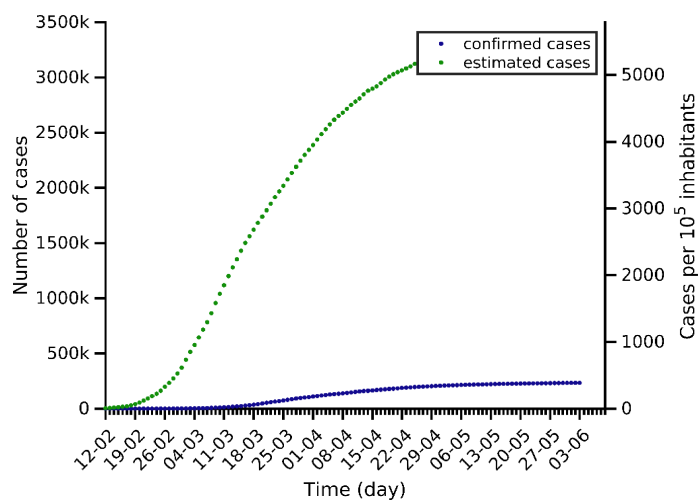
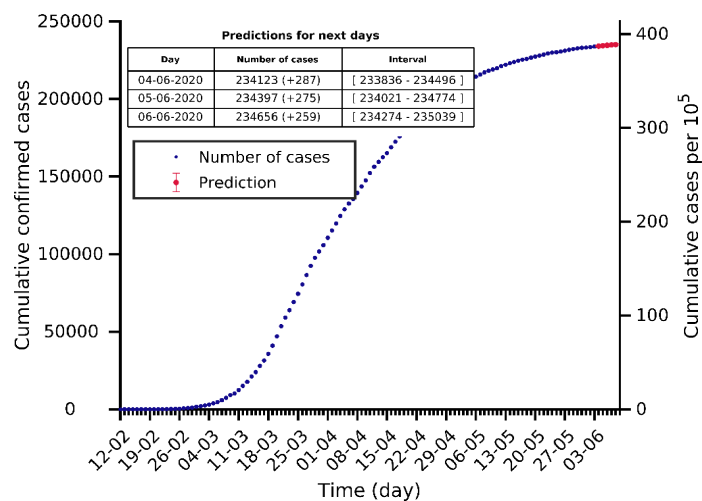
# UK 03-06-2020. Population: 67.9M. Current cumulated incidence: 412/10<sup>5</sup>



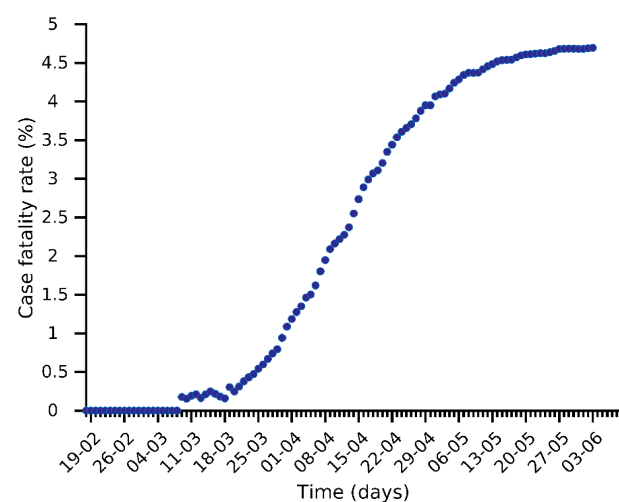
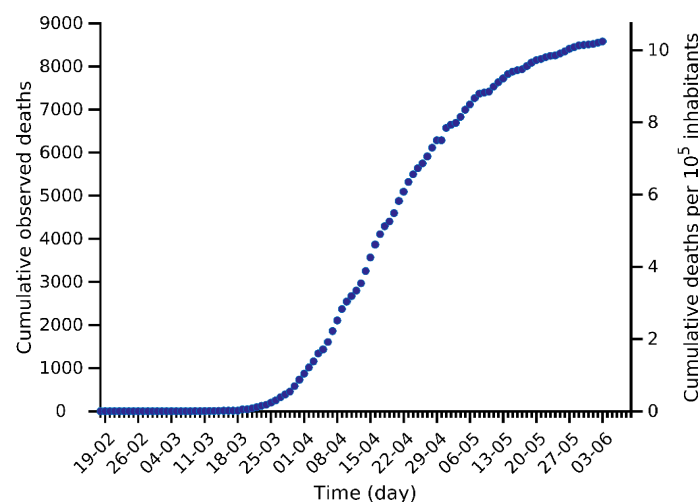
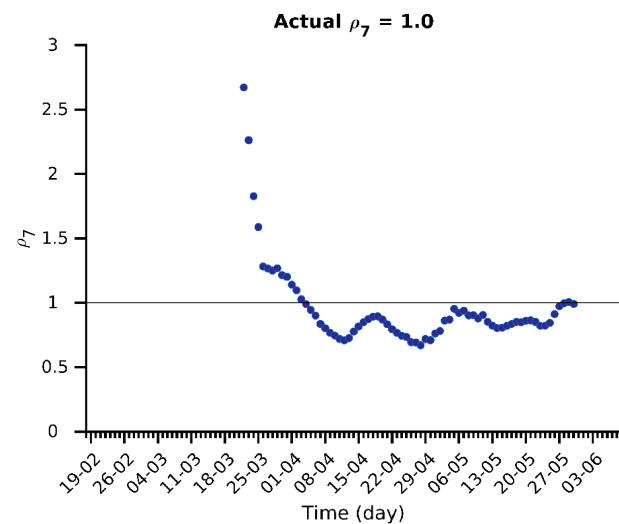
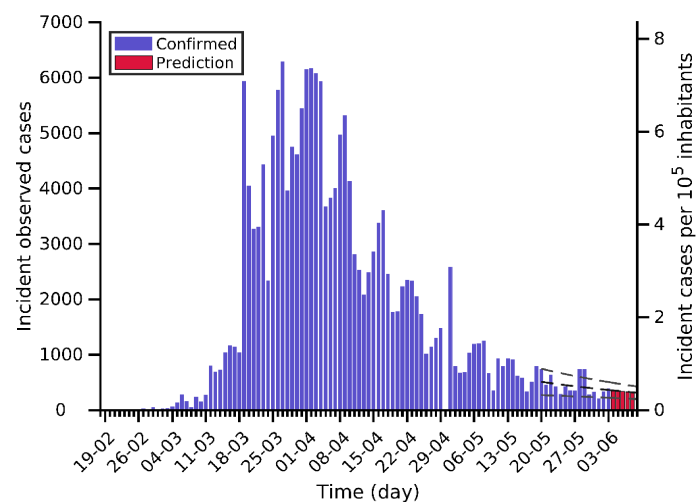
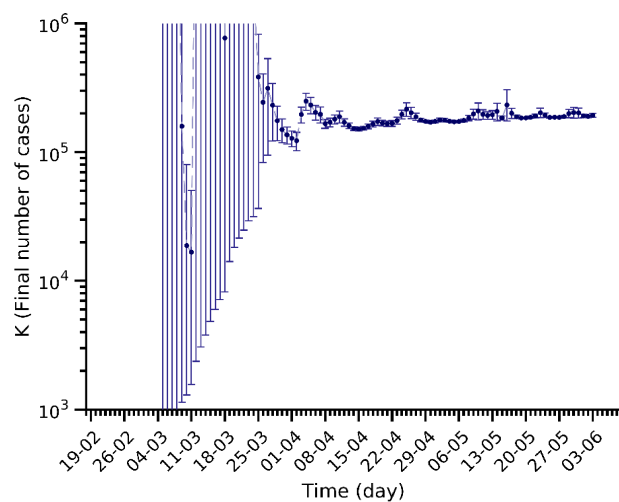
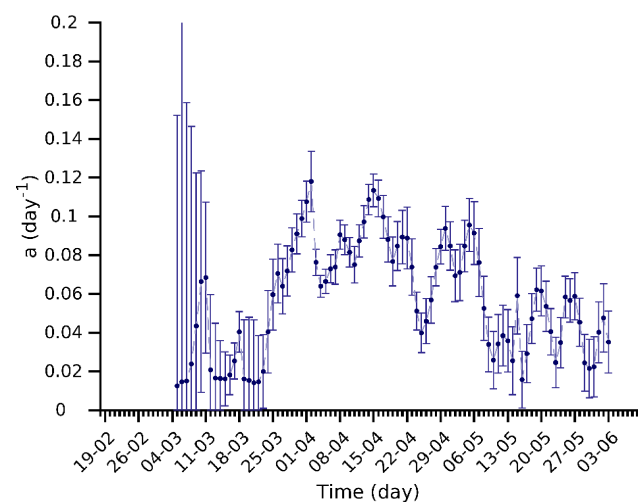
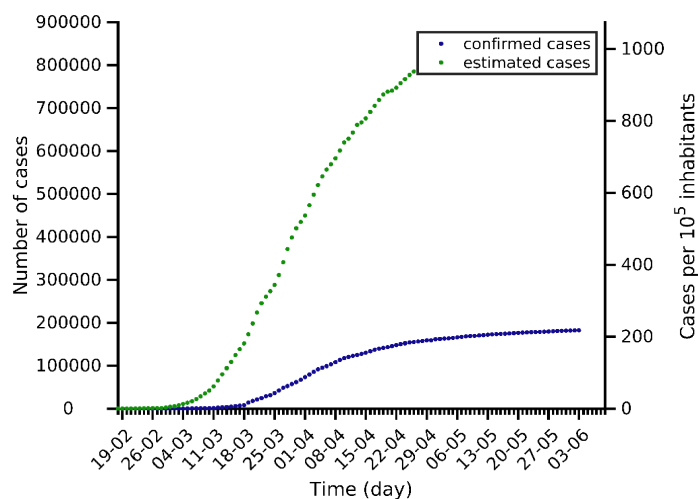
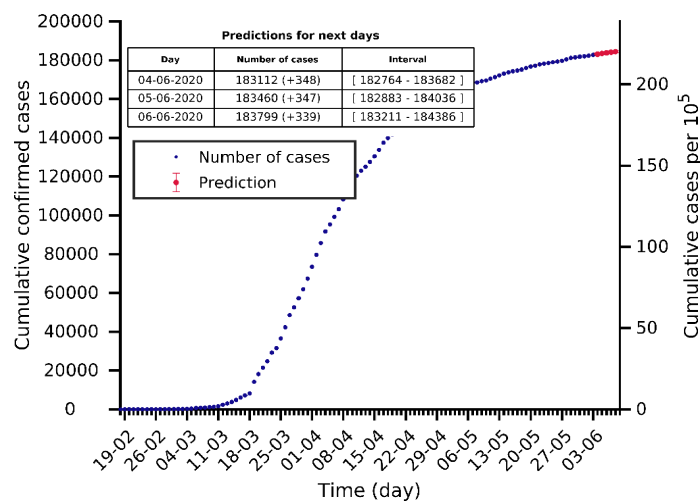
# Spain 02-06-2020. Population: 47.0M. Current cumulated incidence: 511/10<sup>5</sup>



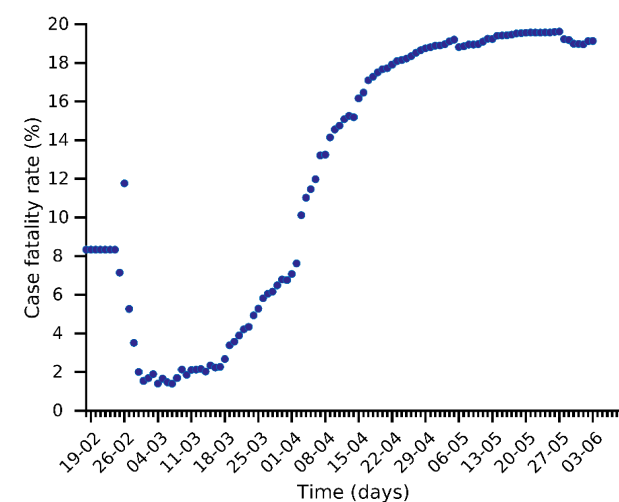
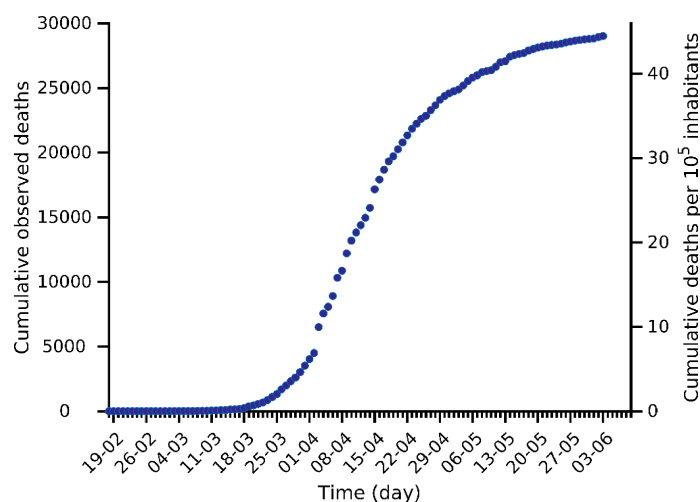
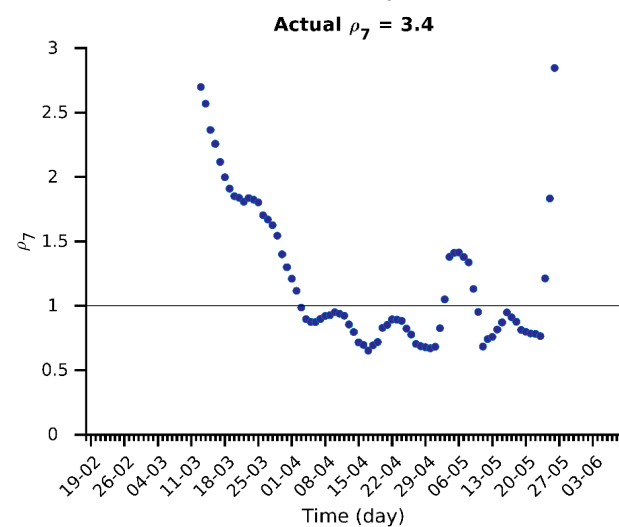
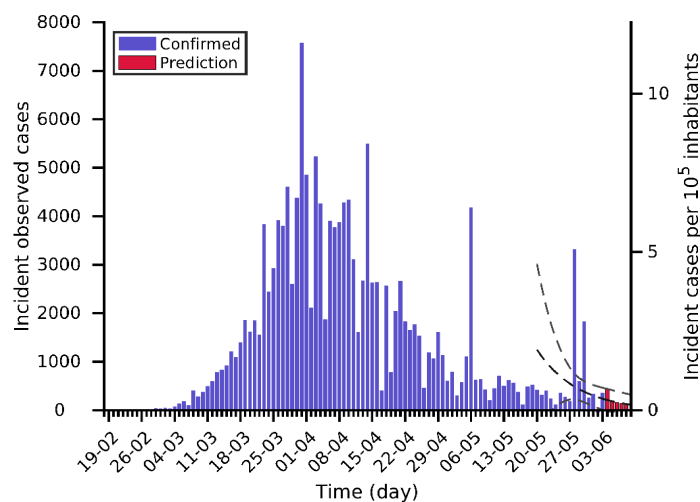
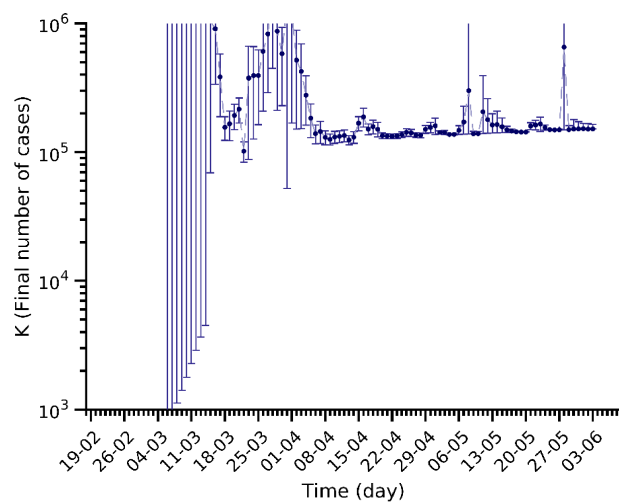
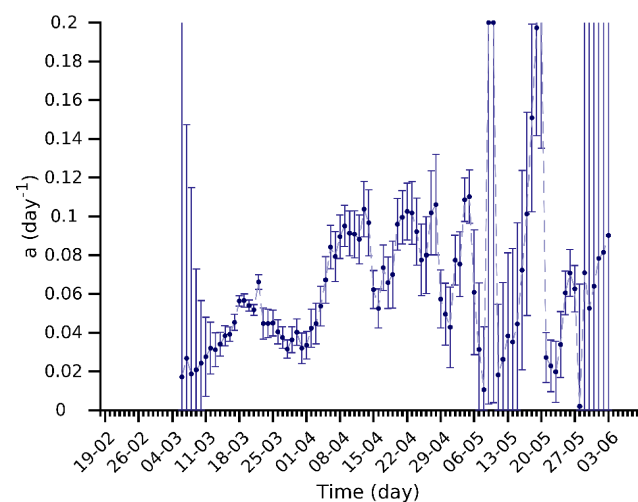
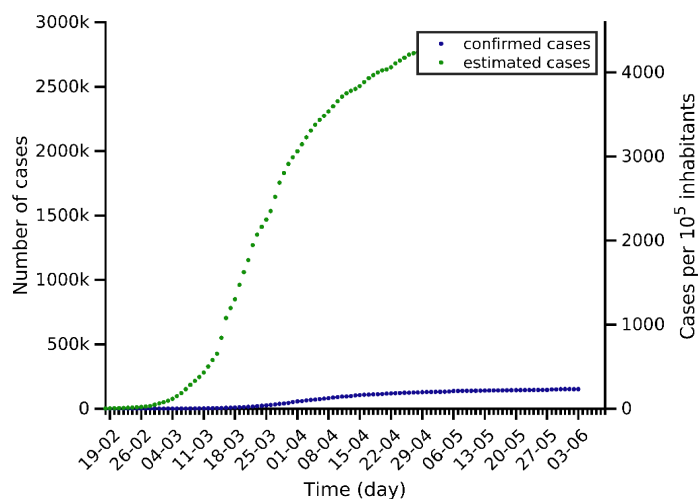
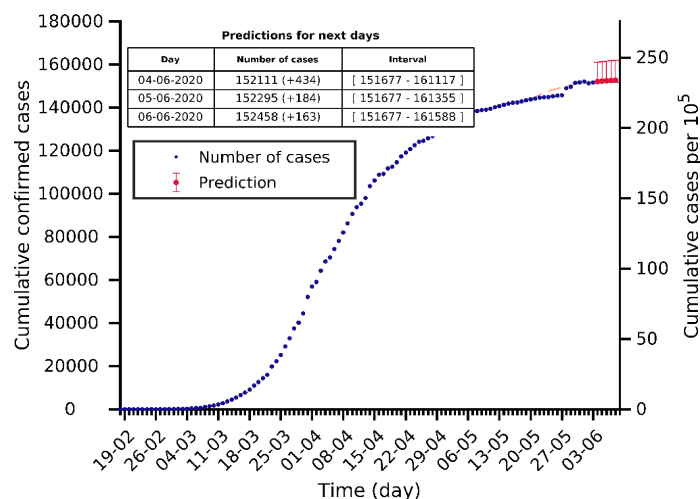
# Italy 03-06-2020. Population: 60.5M. Current cumulated incidence: 387/10<sup>5</sup>



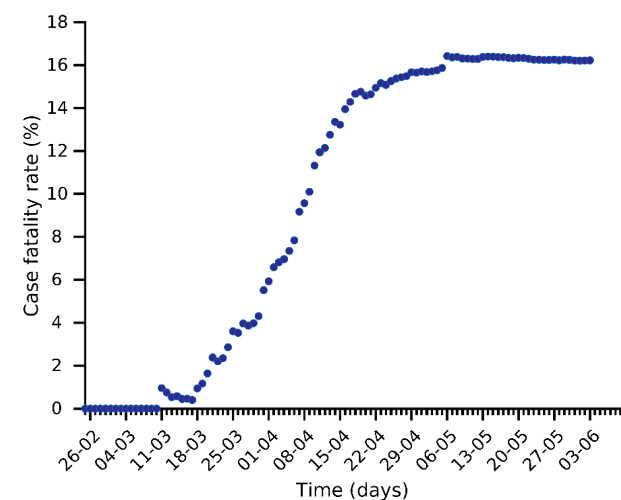
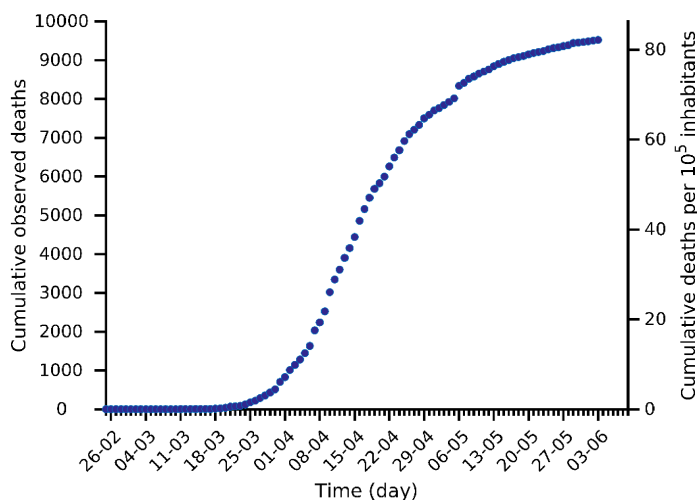
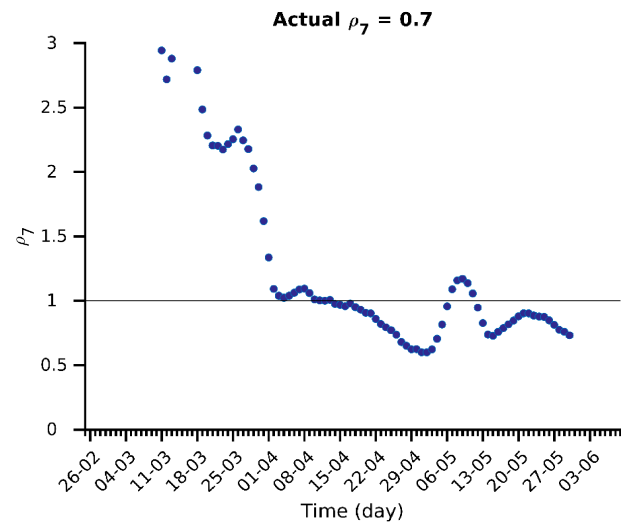
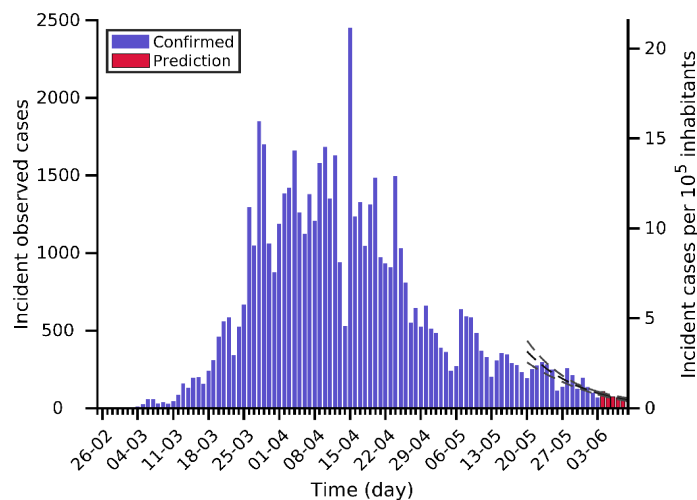
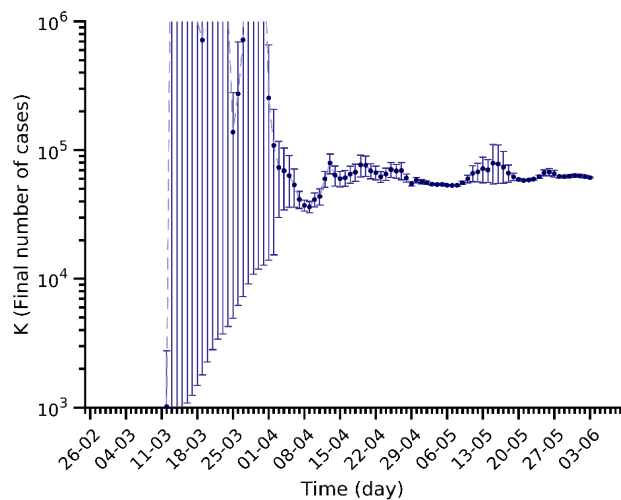
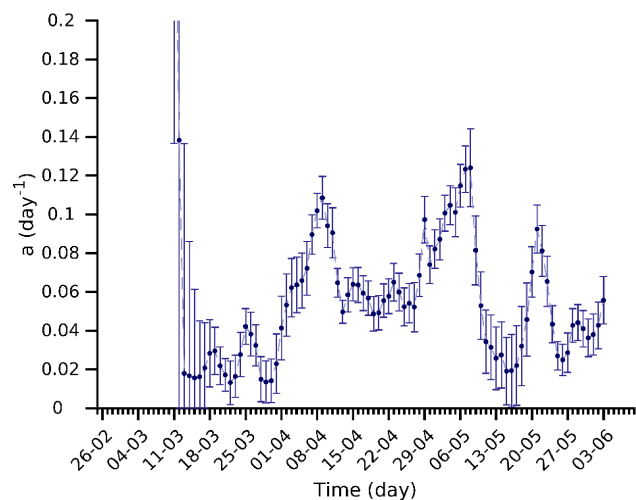
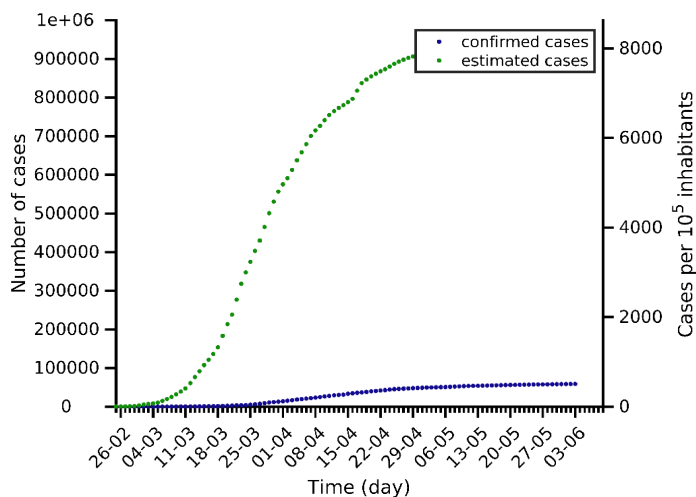
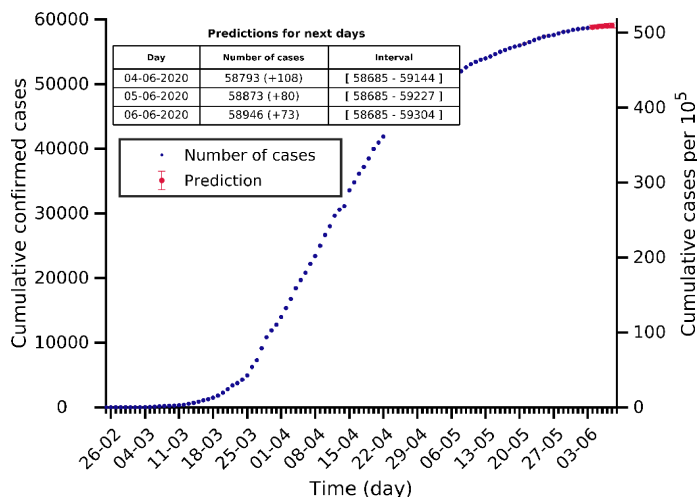
# Germany 03-06-2020. Population: 83.8M. Current cumulated incidence: 218/10<sup>5</sup>



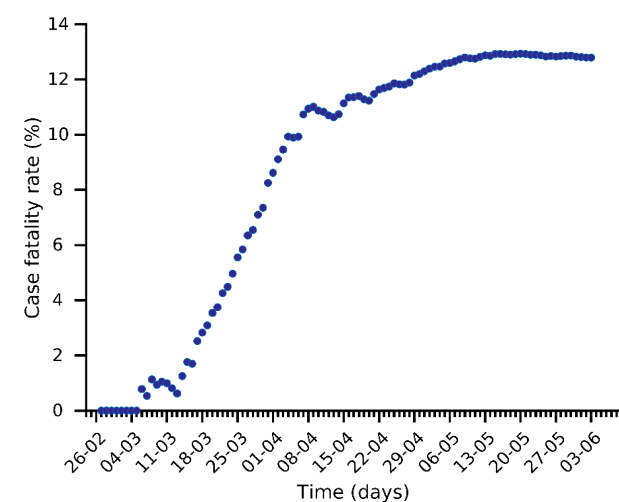
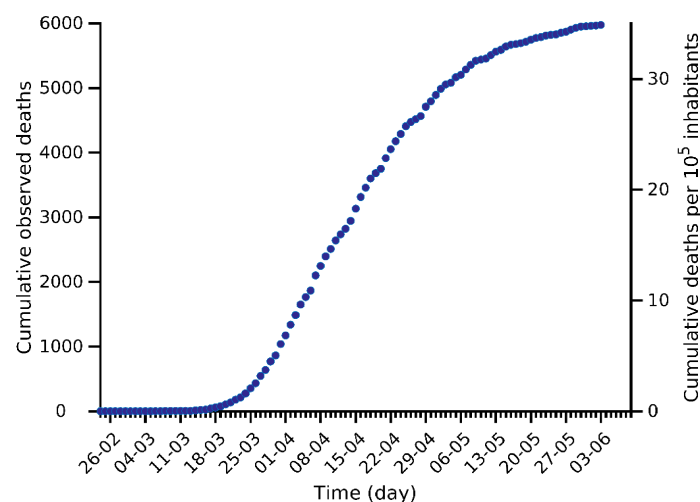
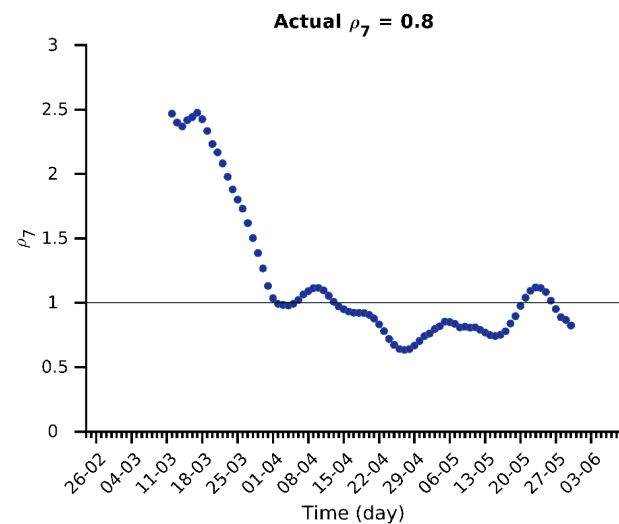
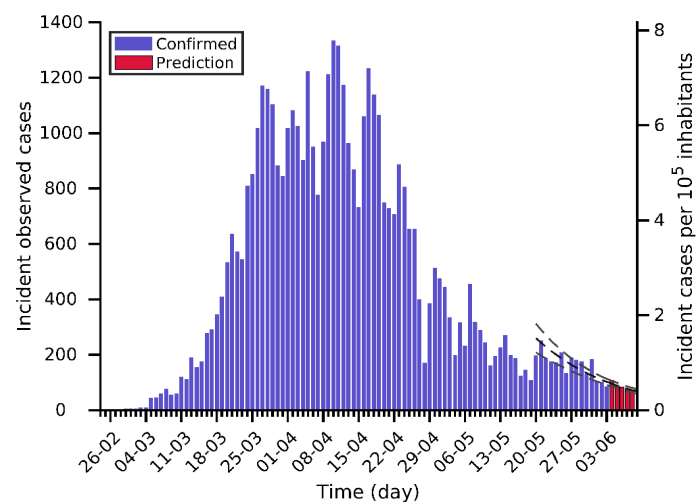
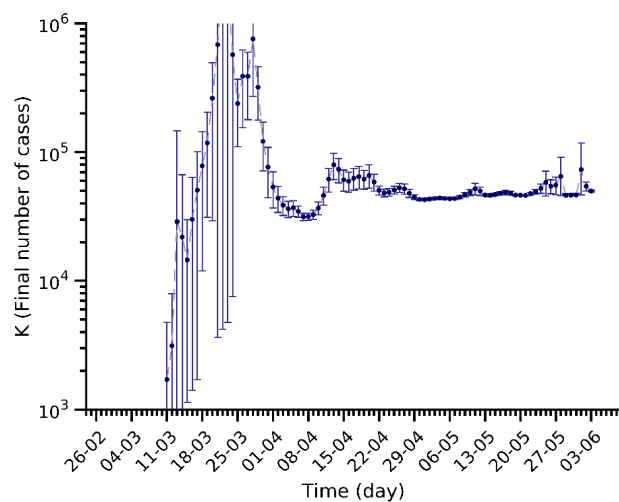
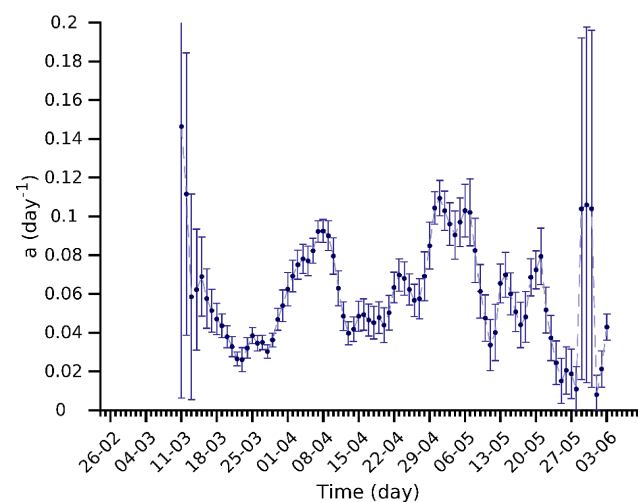
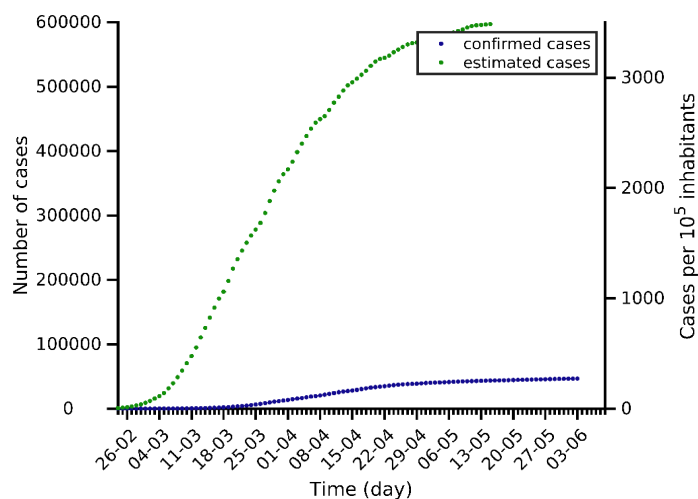
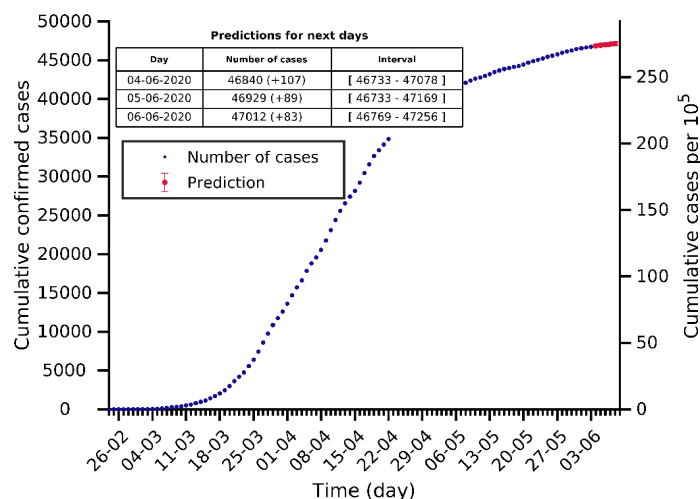
# France 03-06-2020. Population: 65.3M. Current cumulated incidence: 232/10<sup>5</sup>



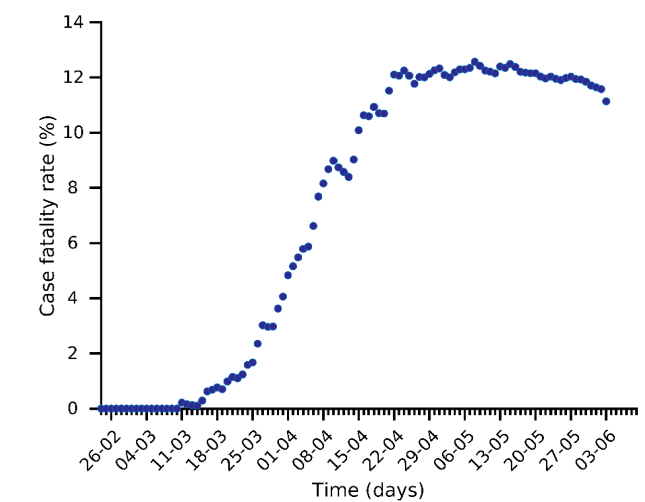
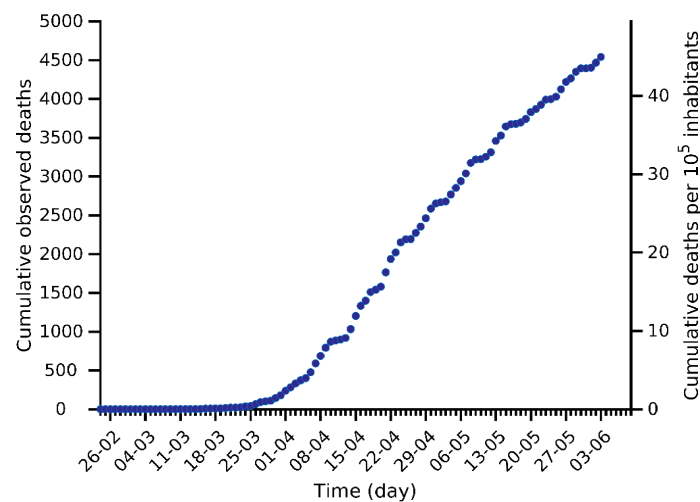
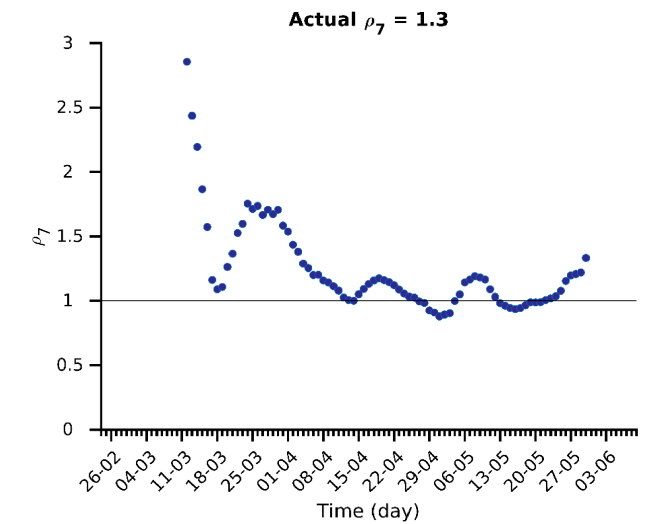
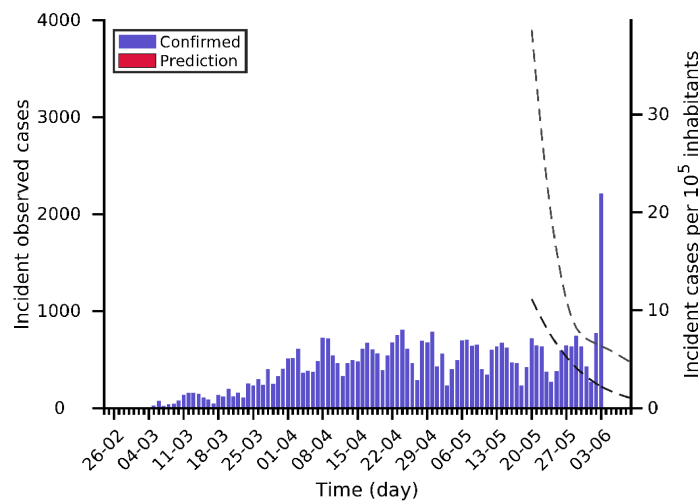
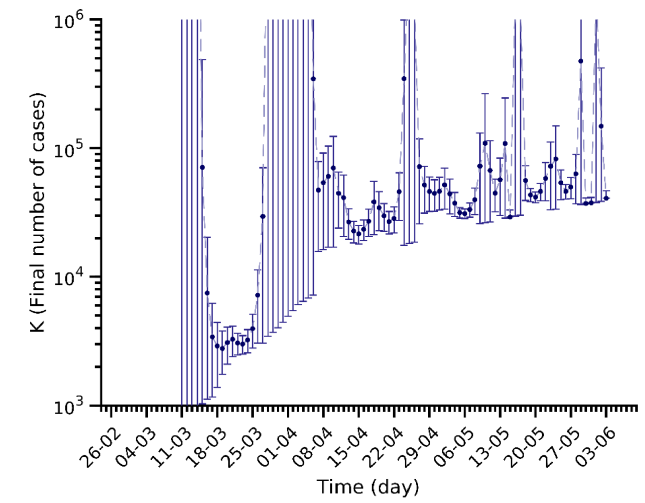
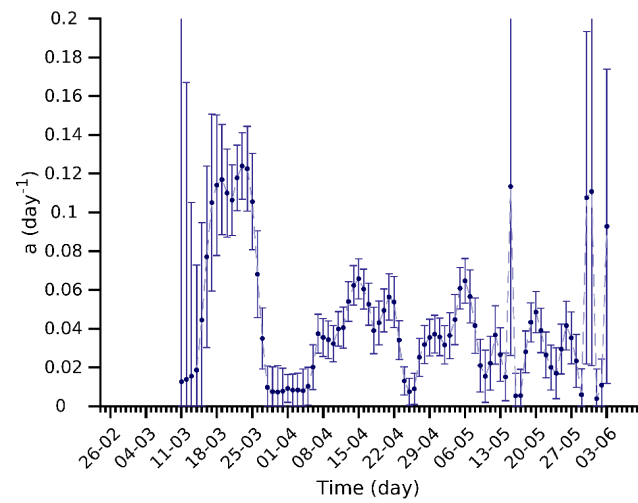
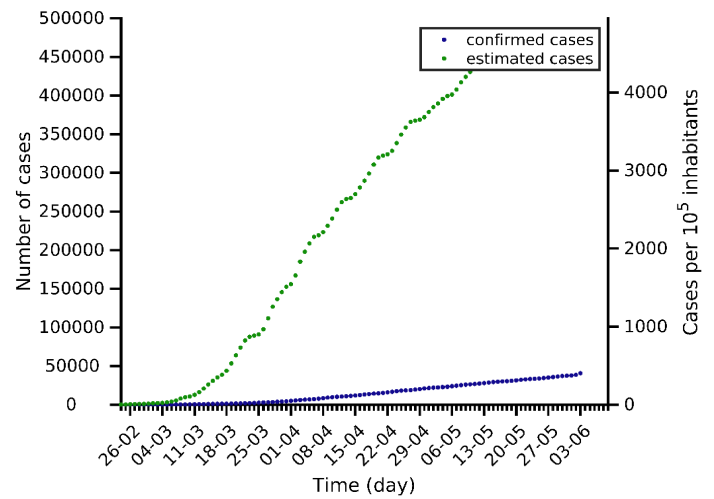
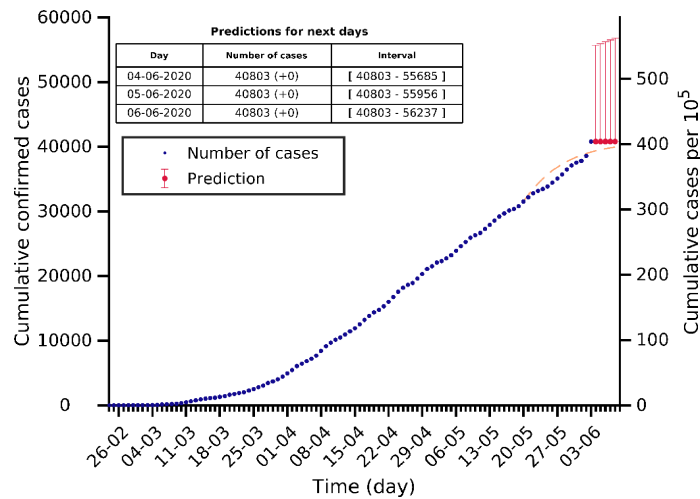
# Belgium 03-06-2020. Population: 11.6M. Current cumulated incidence: 506/10<sup>5</sup>



# Netherlands 03-06-2020. Population: 17.1M. Current cumulated incidence: 273/10<sup>5</sup>

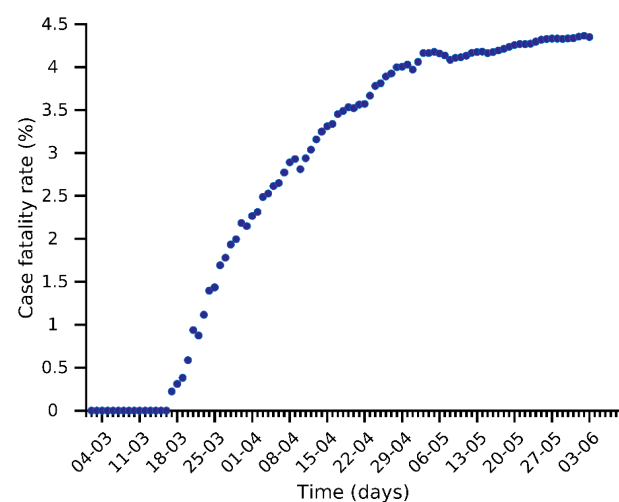
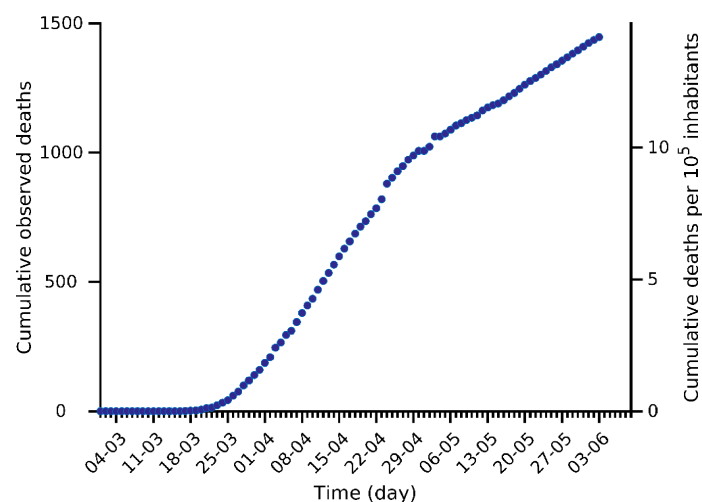
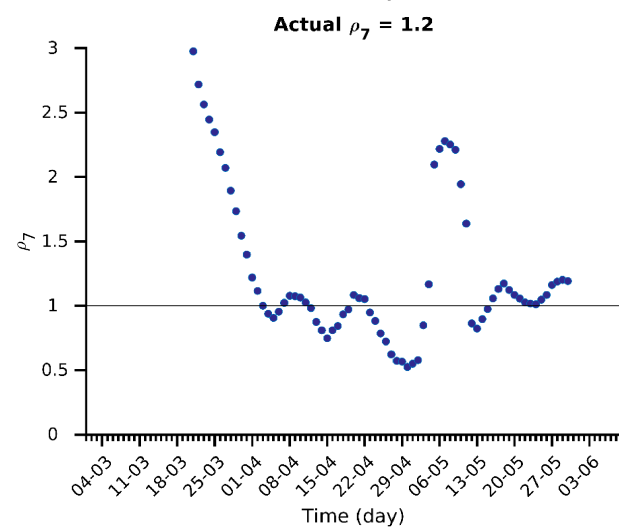
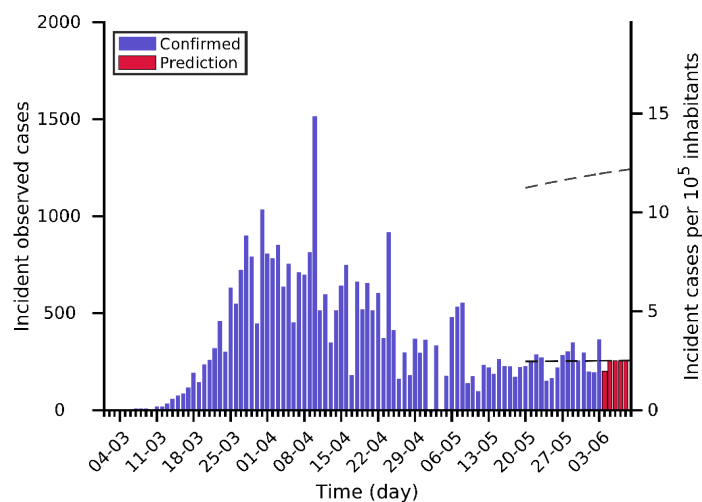
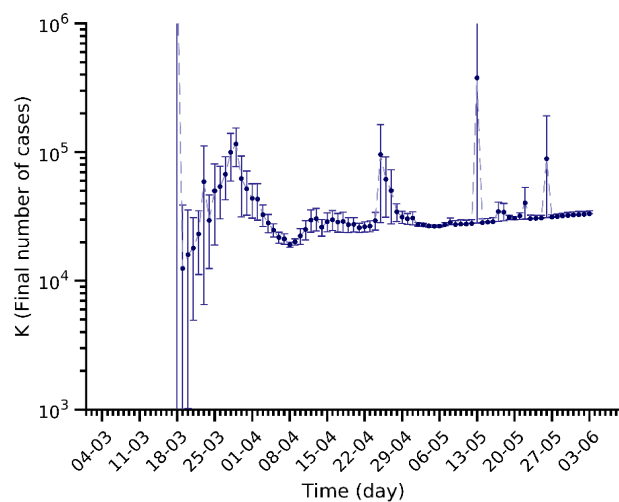
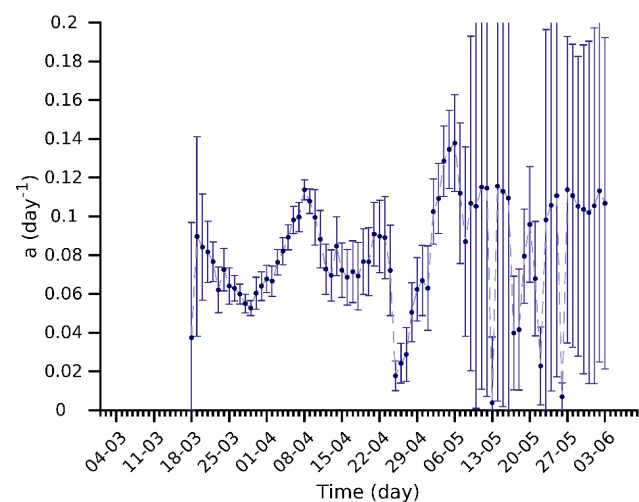
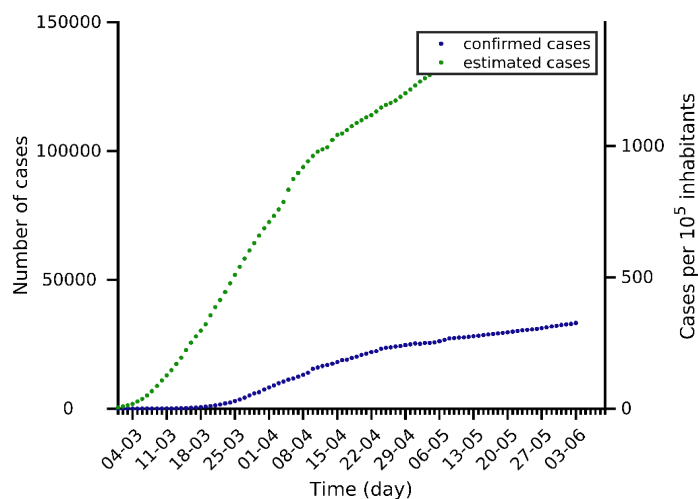
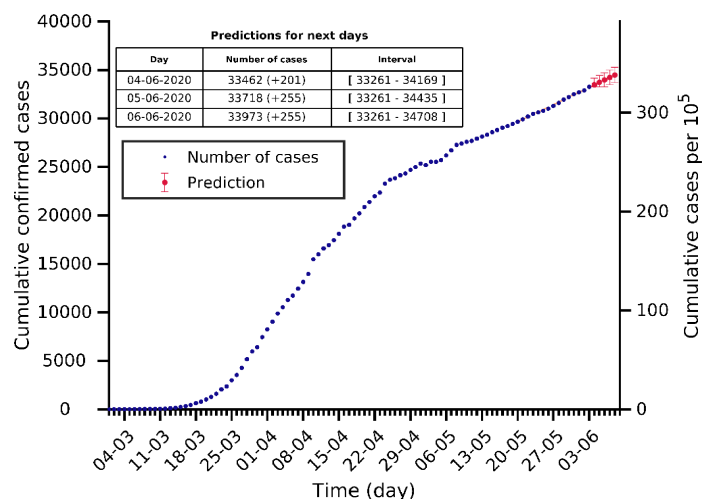


# Sweden 03-06-2020. Population: 10.1M. Current cumulated incidence: 404/10<sup>5</sup>

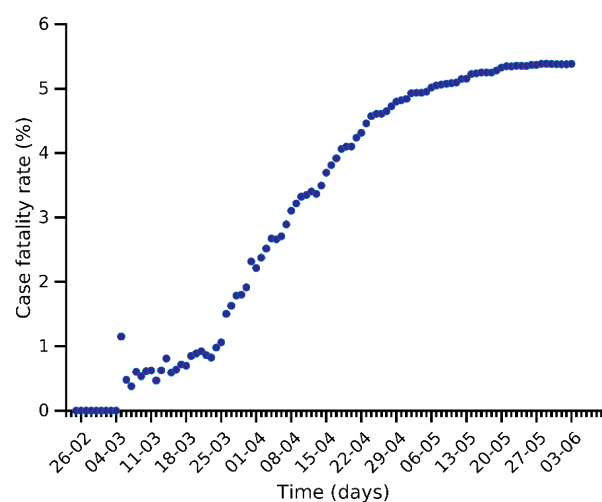
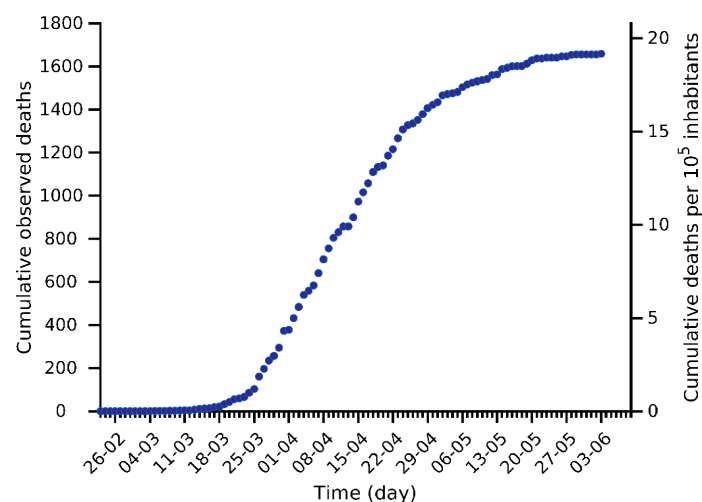
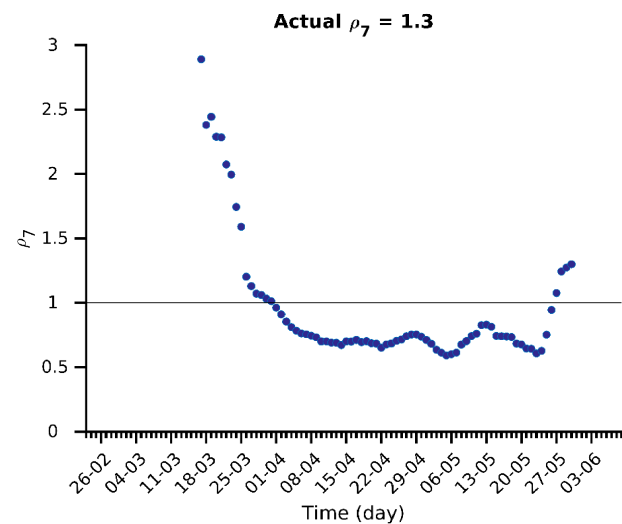
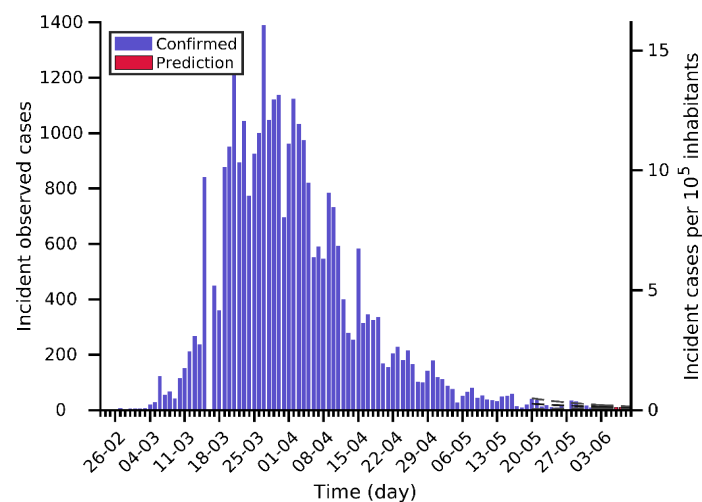
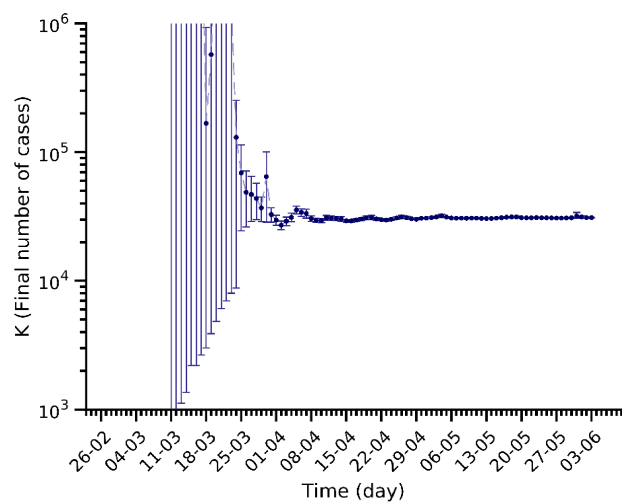
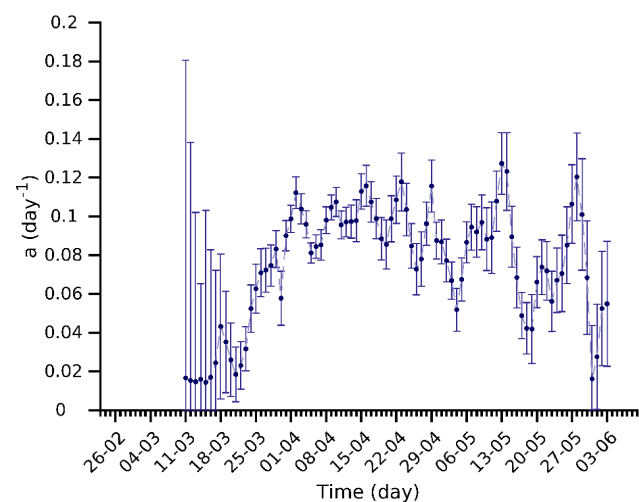
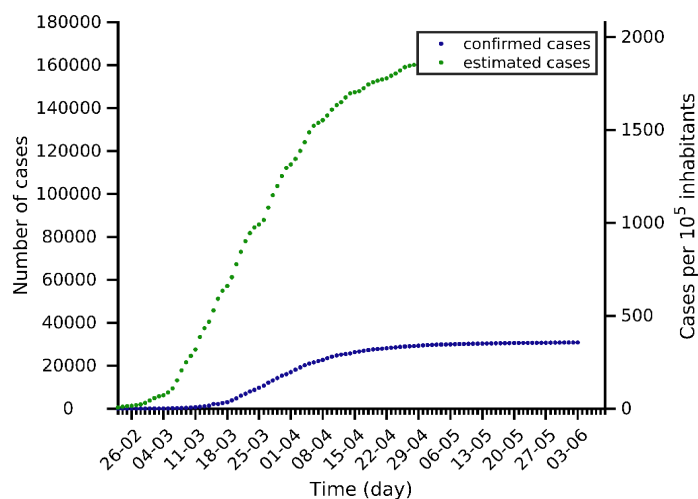
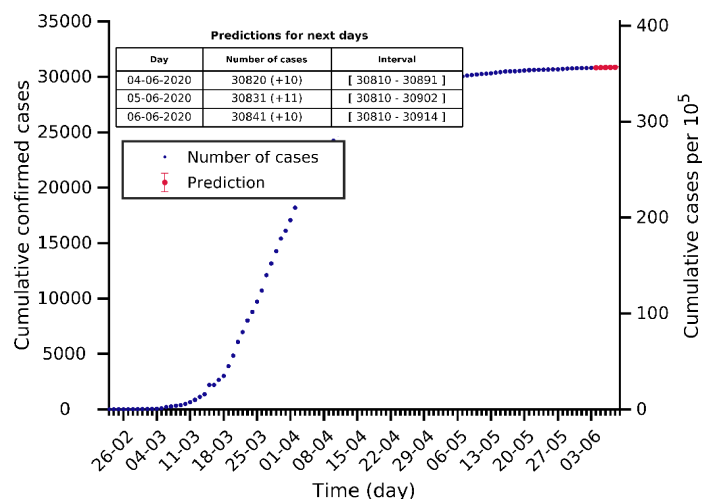




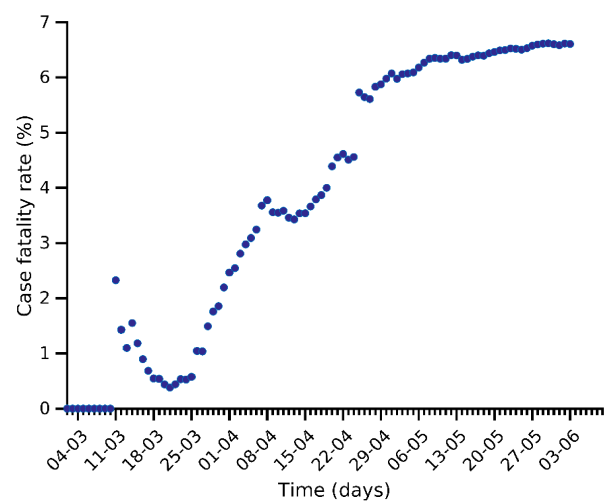
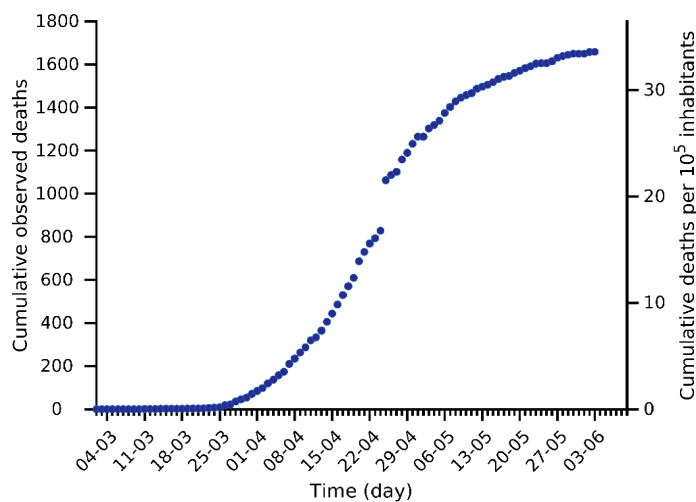
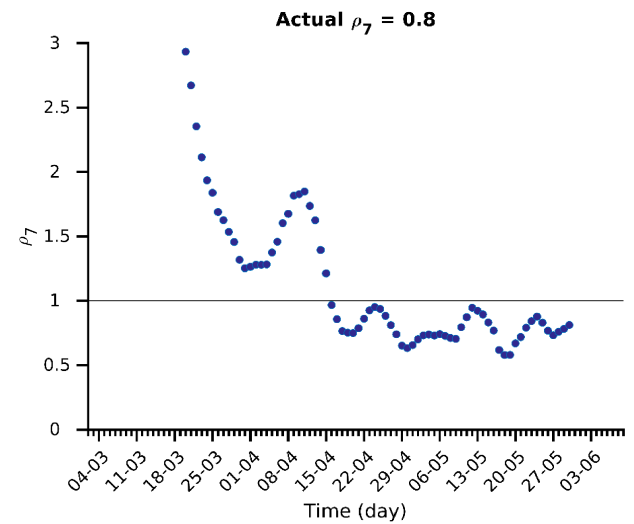
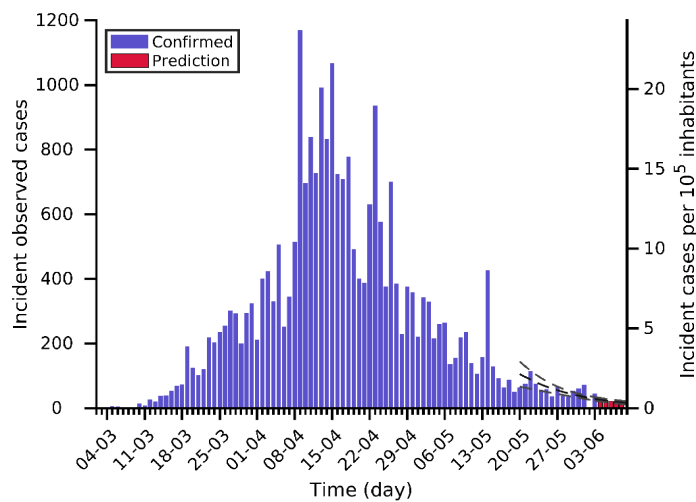
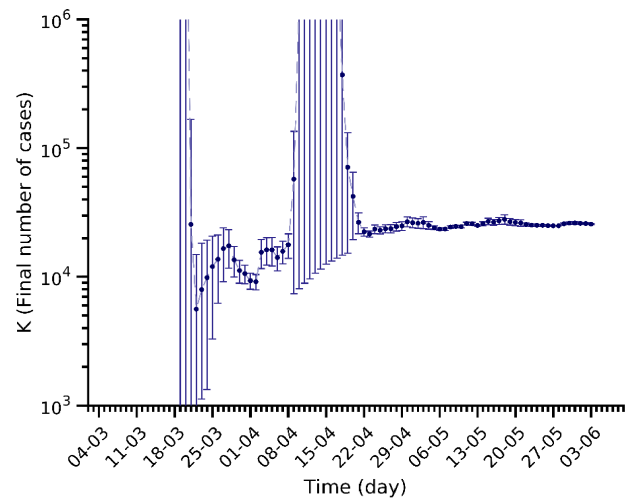
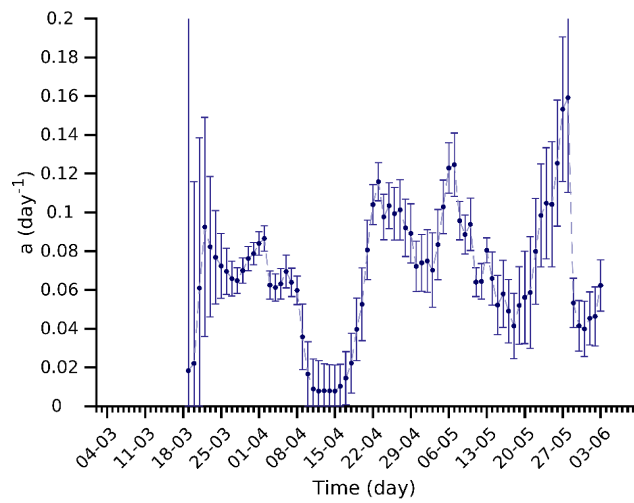
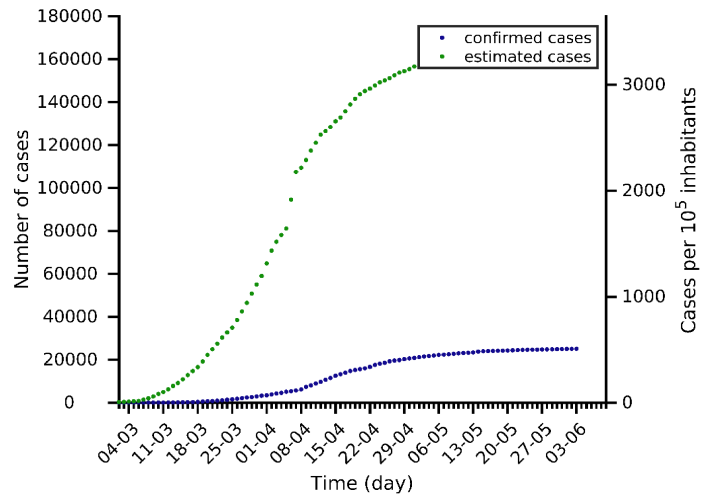
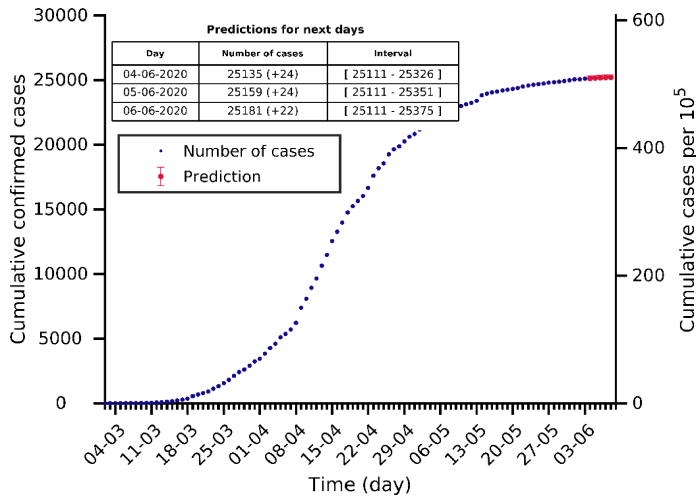
# Portugal 03-06-2020. Population: 10.2M. Current cumulated incidence: 326/10<sup>5</sup>



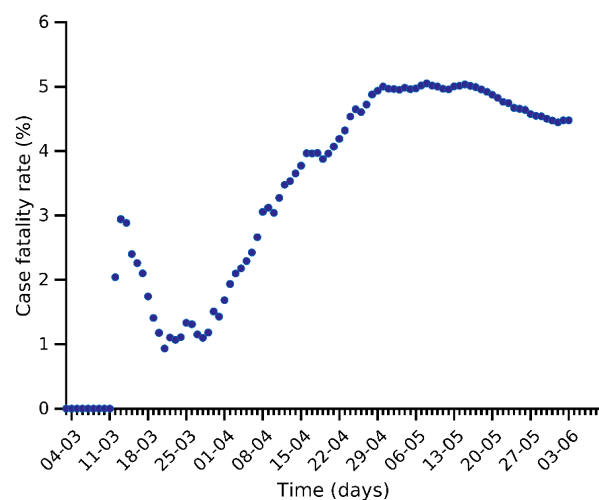
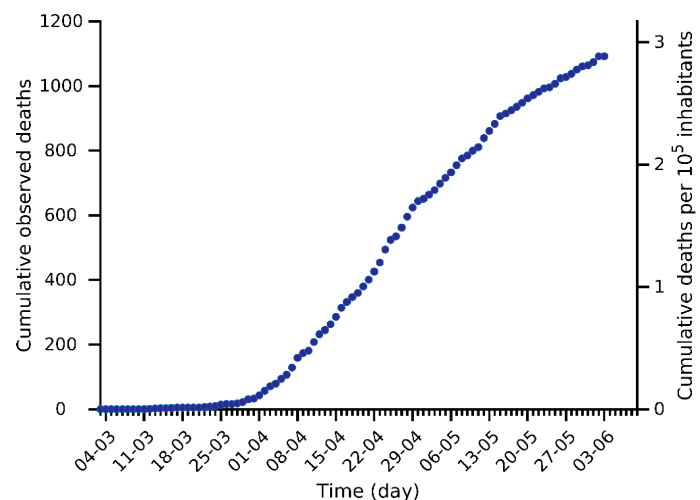
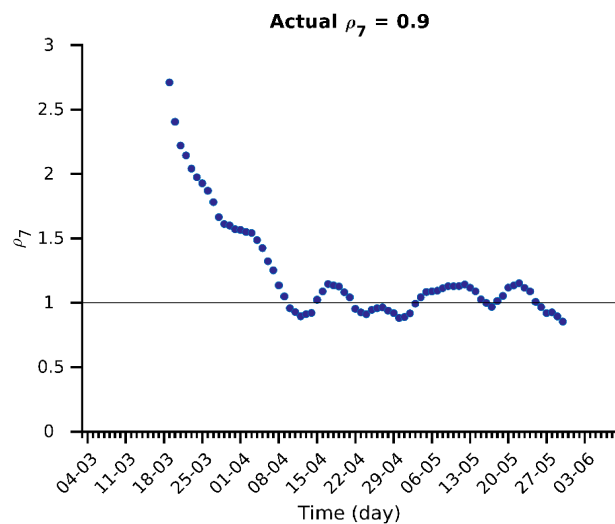
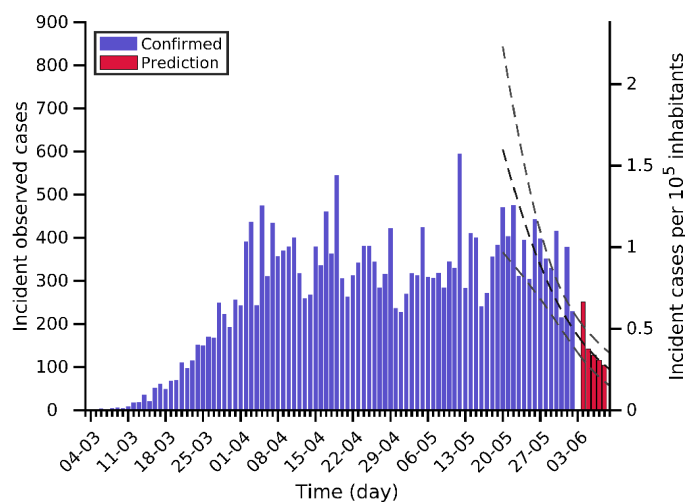
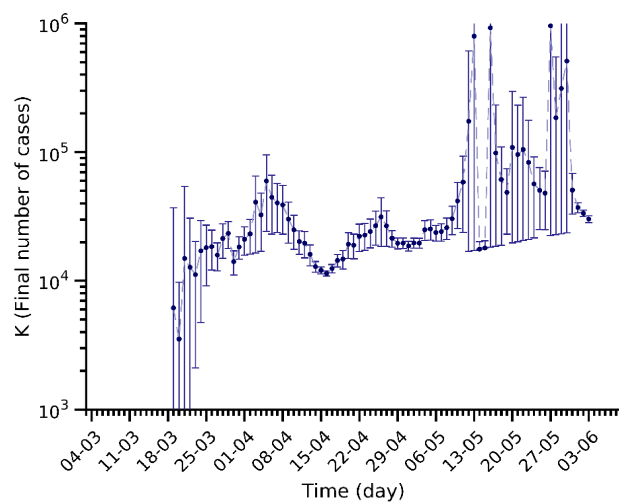
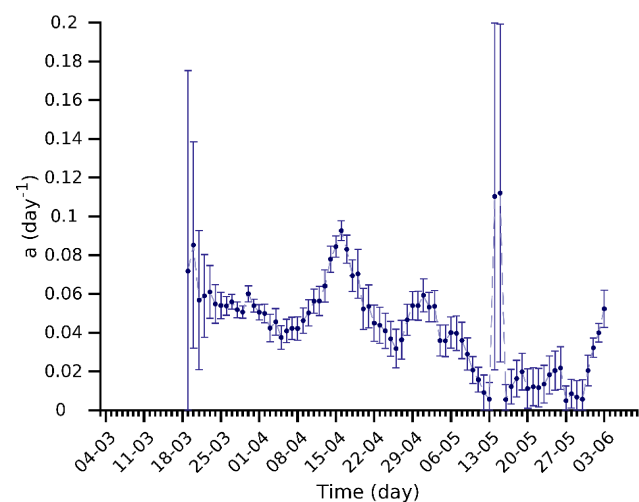
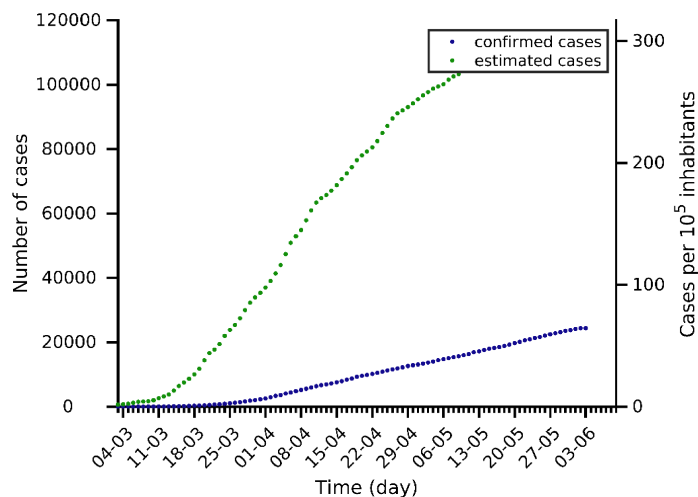
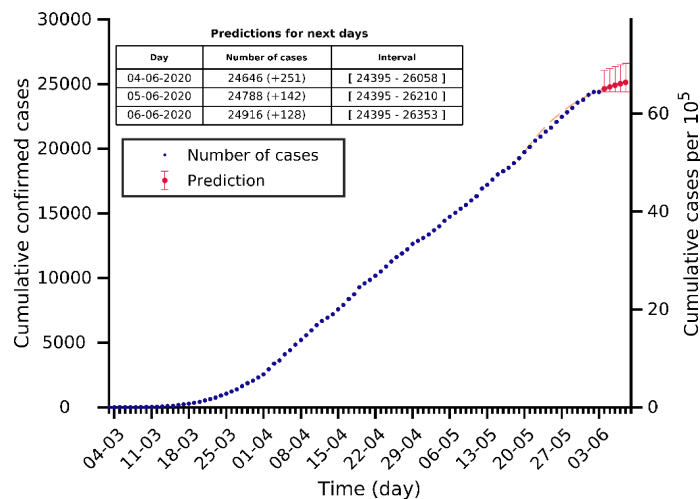
# Switzerland 03-06-2020. Population: 8.7M. Current cumulated incidence: 356/10<sup>5</sup>



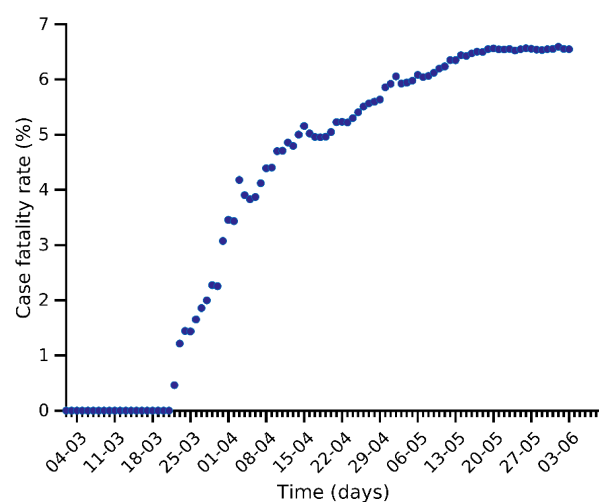
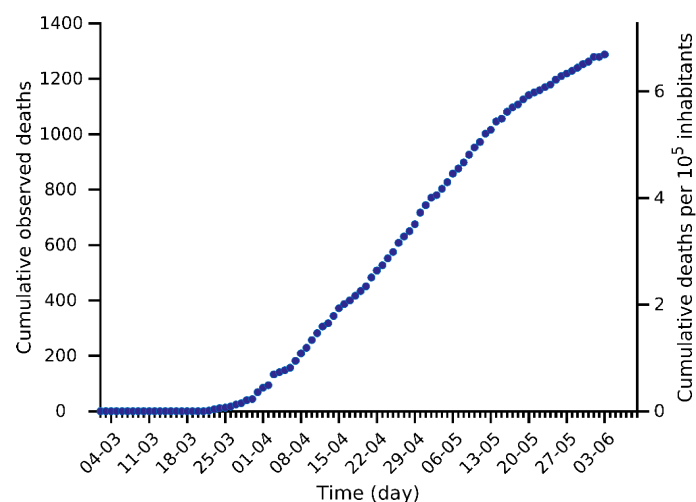
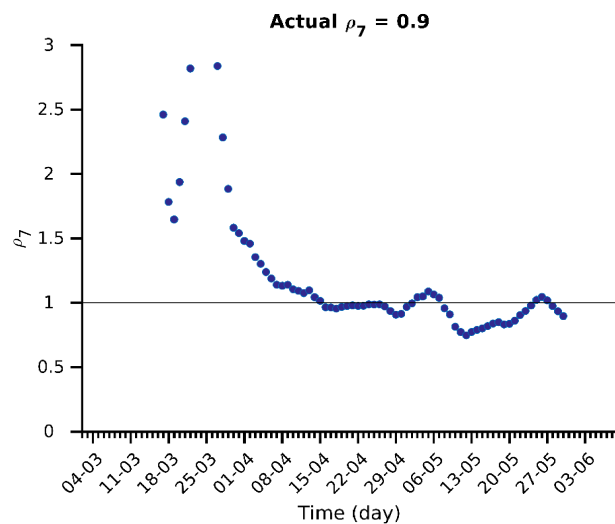
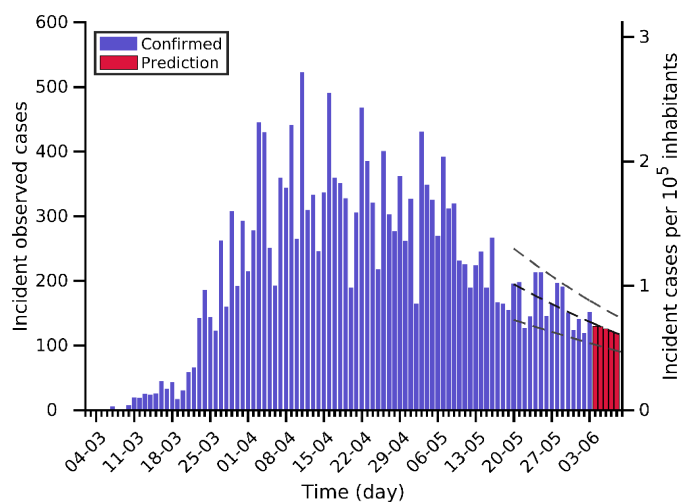
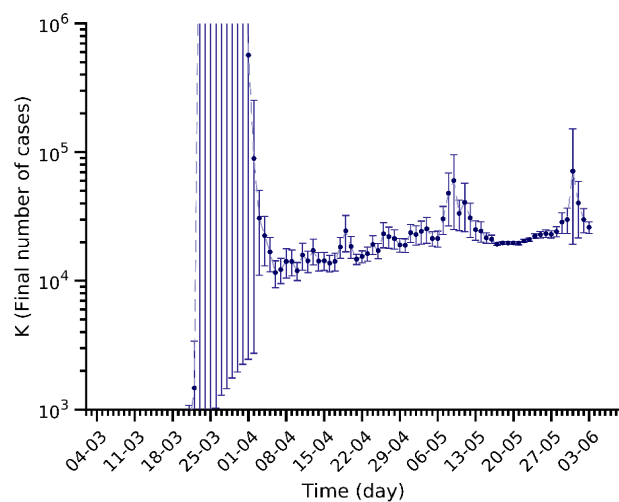
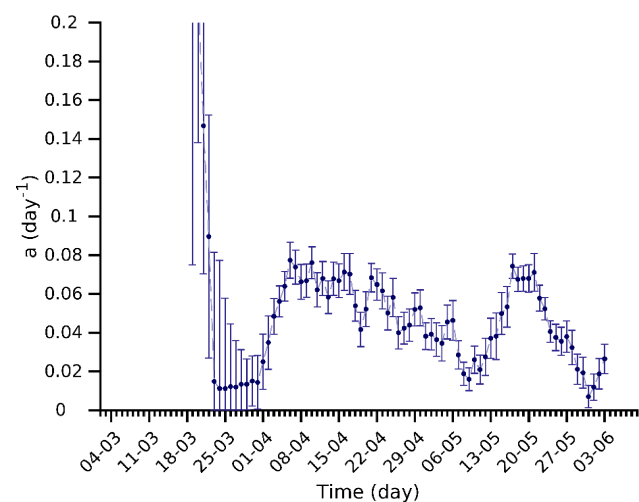
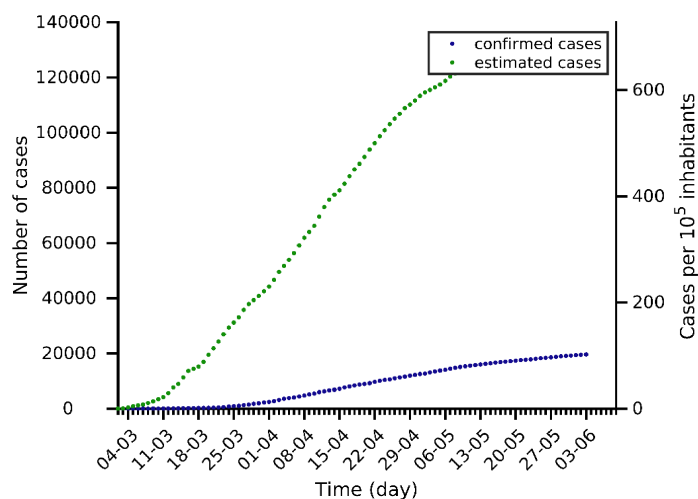
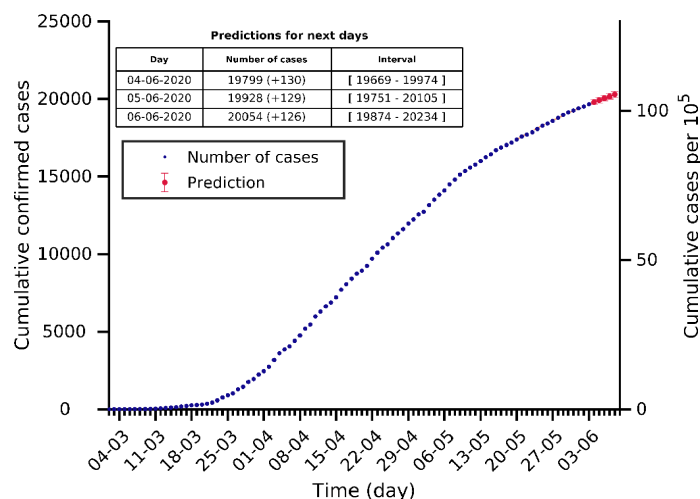
# Ireland 03-06-2020. Population: 4.9M. Current cumulated incidence: 509/10<sup>5</sup>



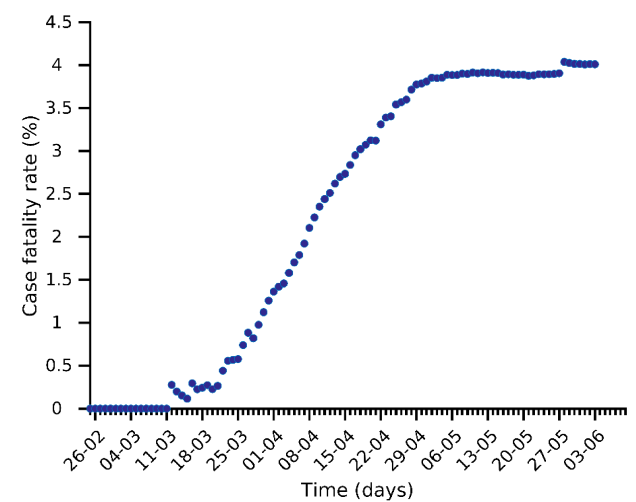
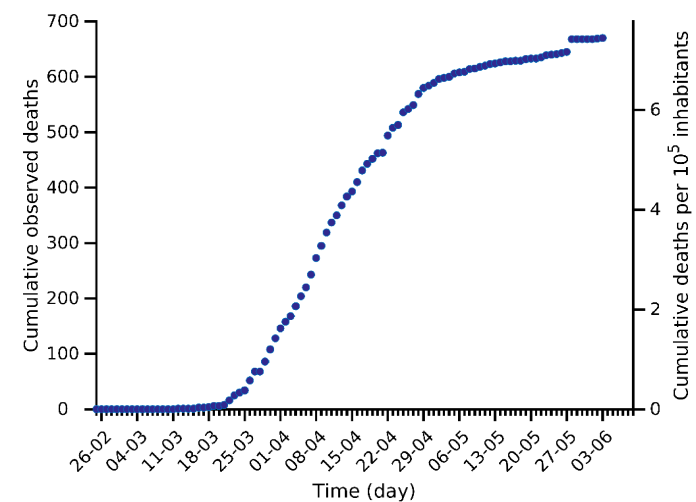
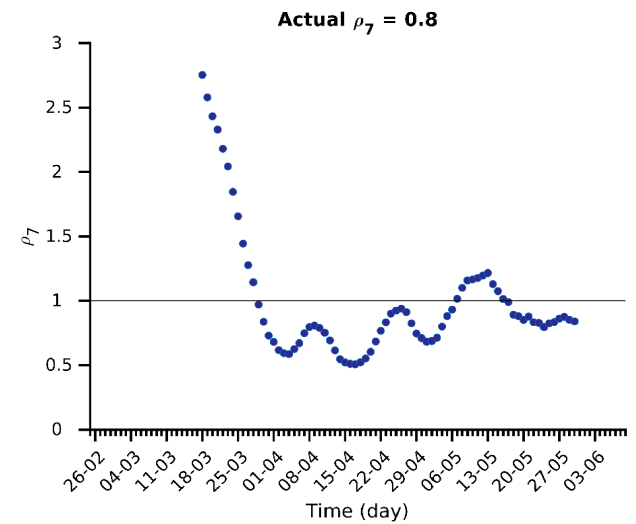
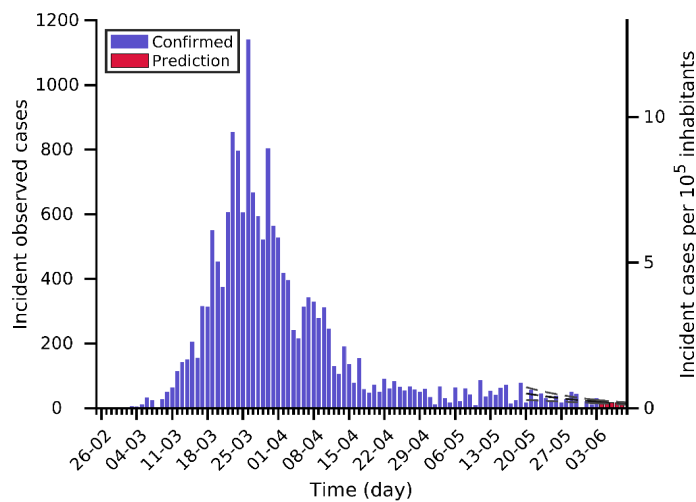
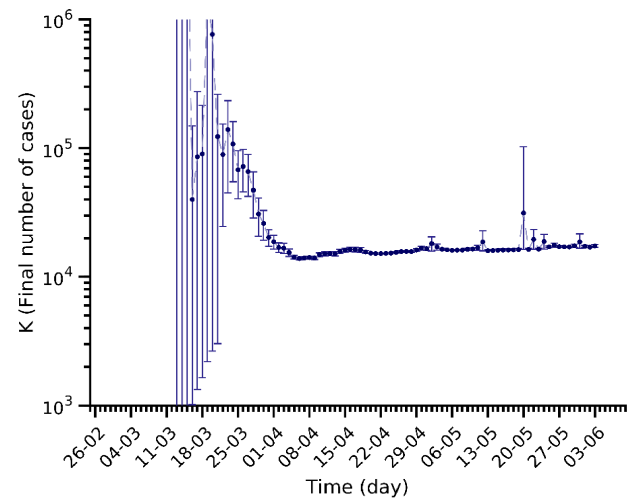
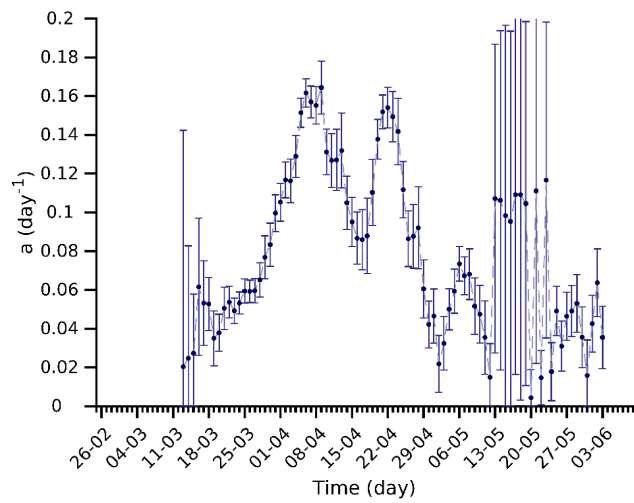
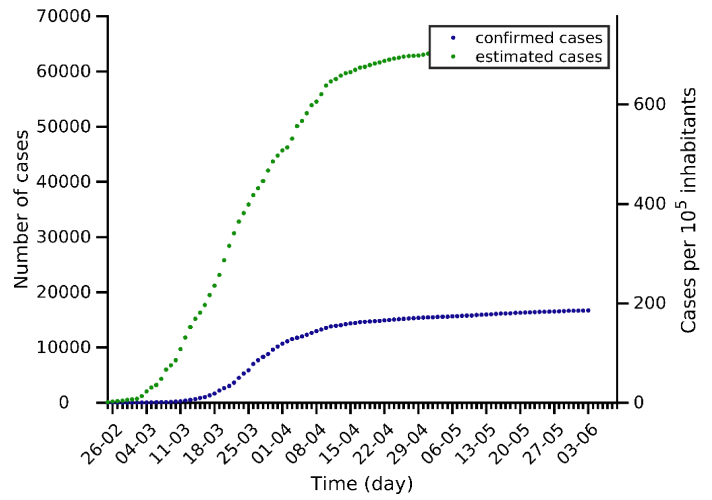
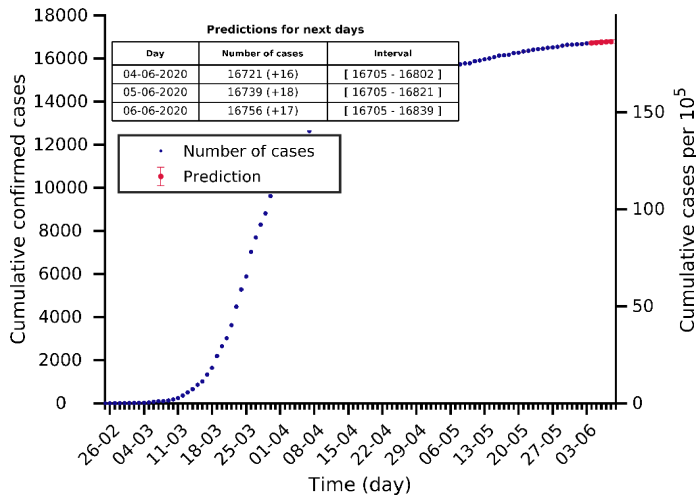
**Poland 03-06-2020. Population: 37.8M. Current cumulated incidence: 64/10<sup>5</sup>**



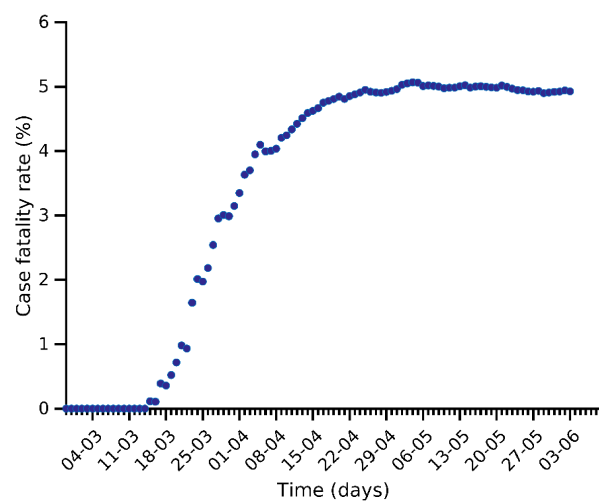
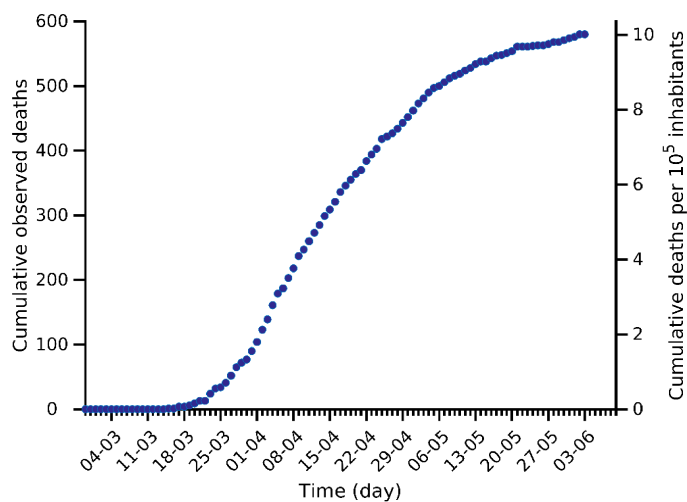
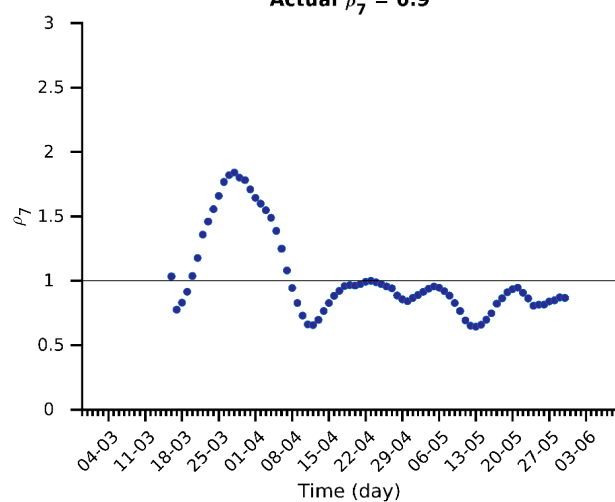
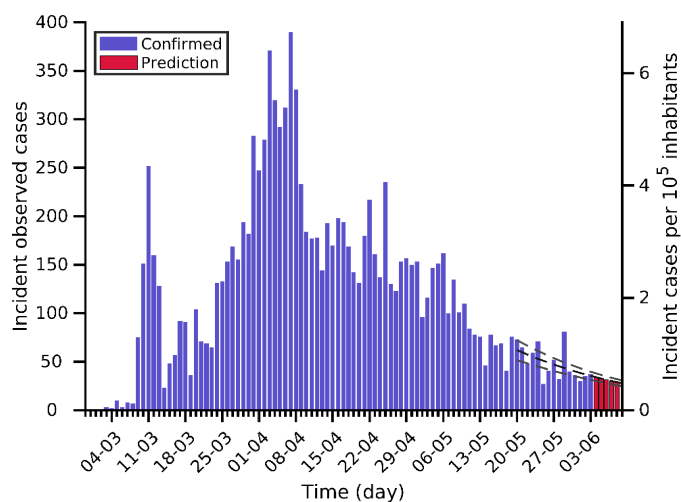
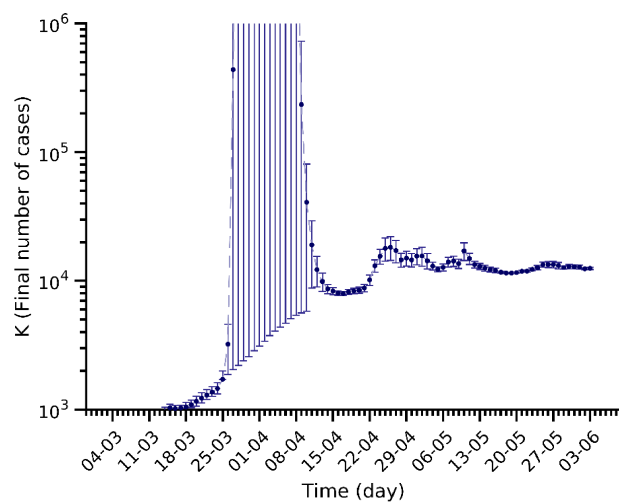
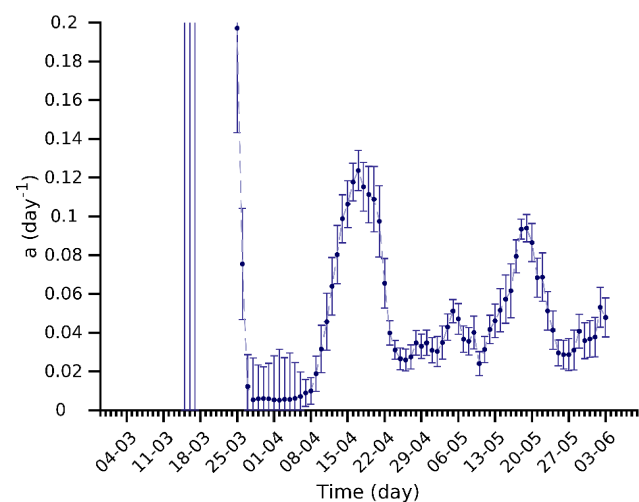
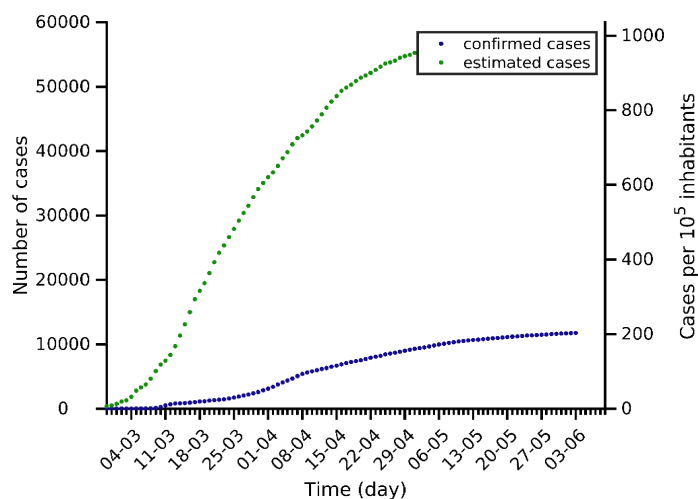
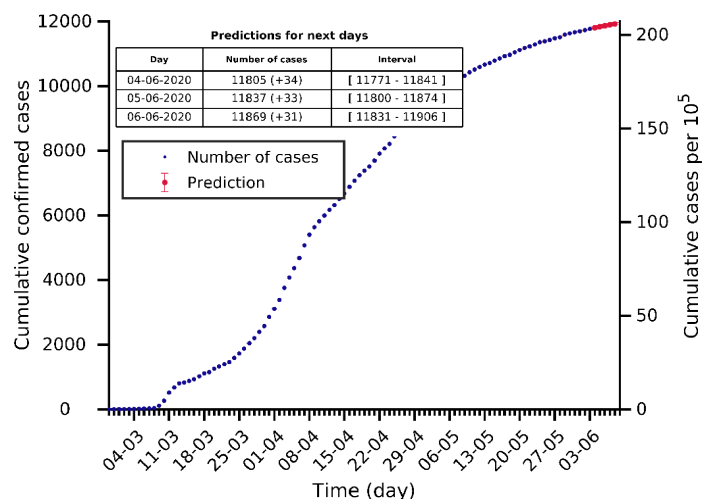
# Romania 03-06-2020. Population: 19.2M. Current cumulated incidence: 102/10<sup>5</sup>

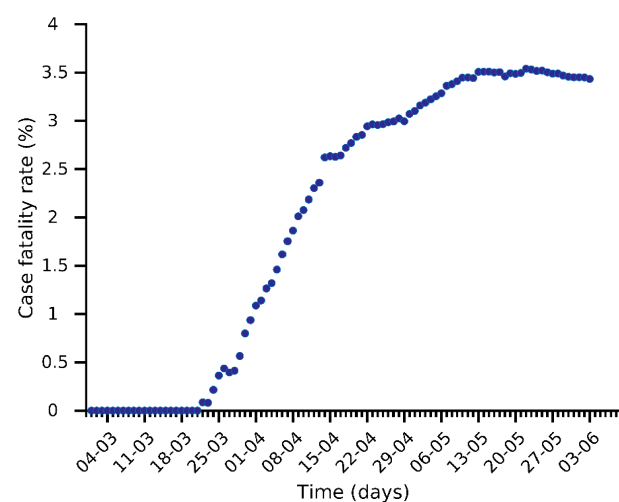
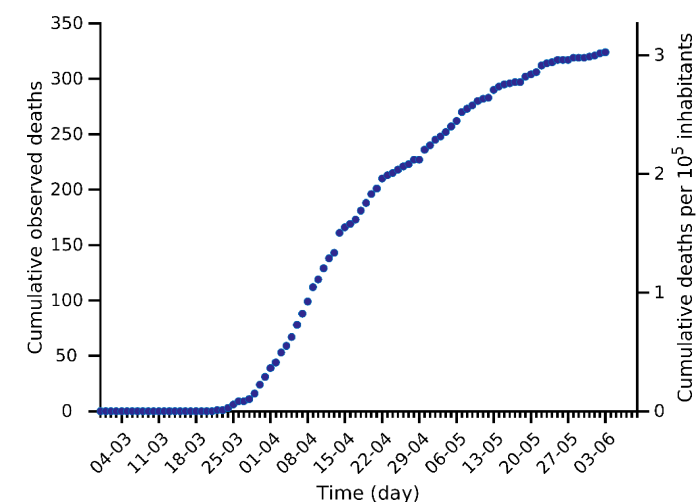
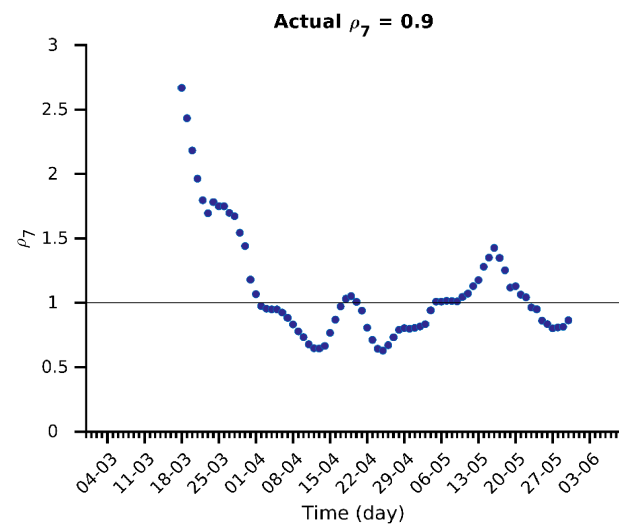
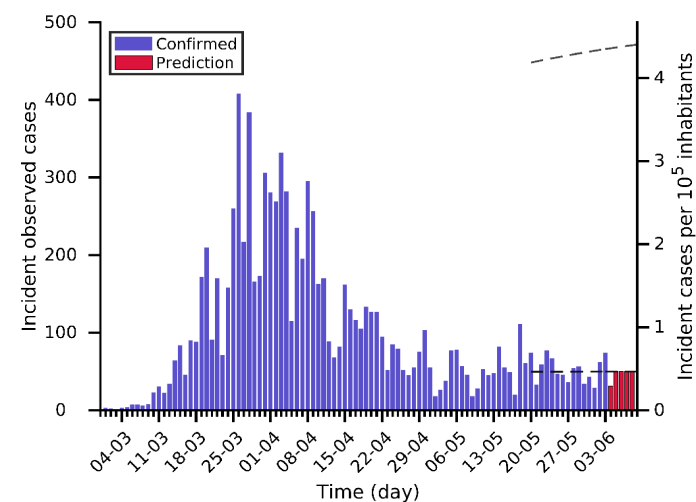
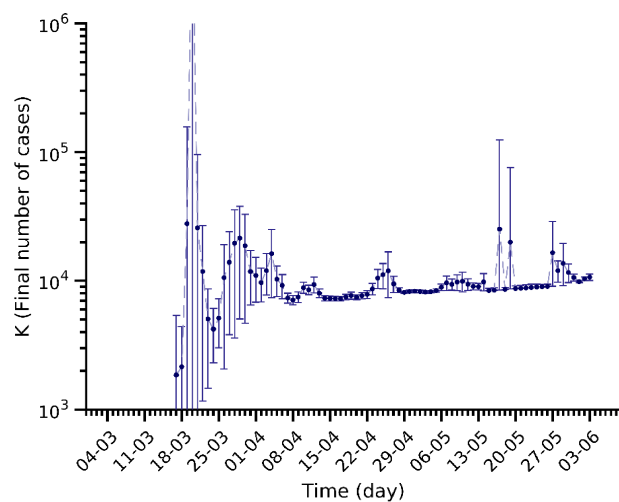
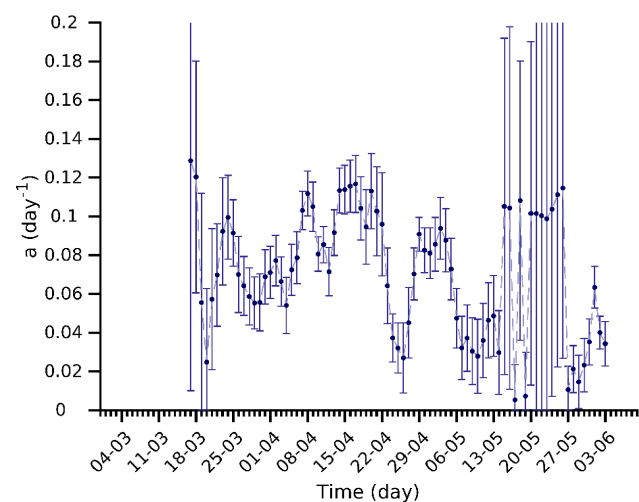
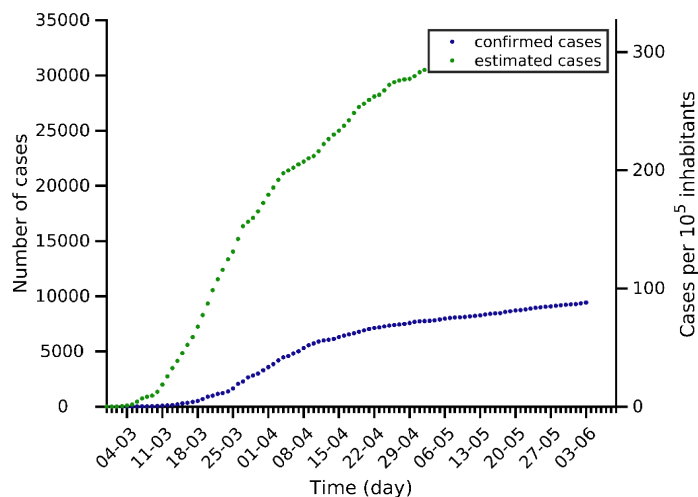
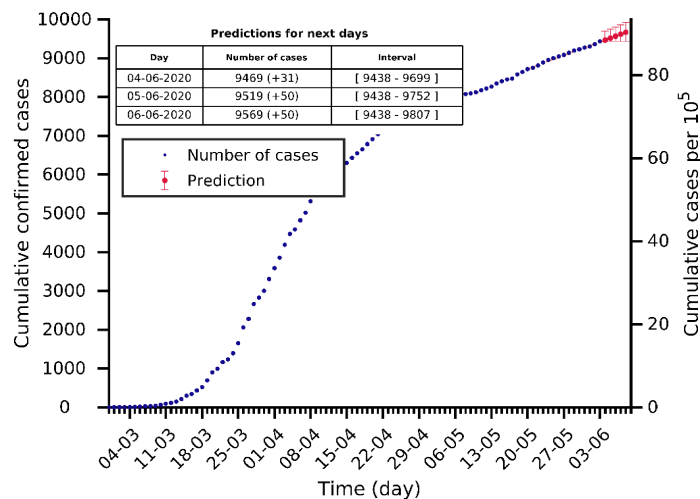


# Austria 03-06-2020. Population: 9.0M. Current cumulated incidence: 185/10<sup>5</sup>



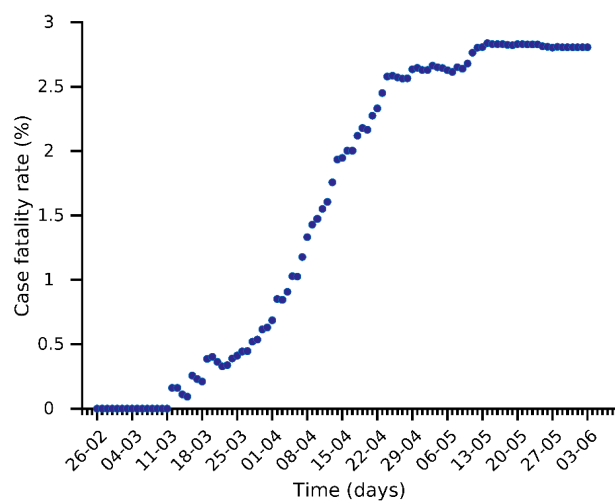
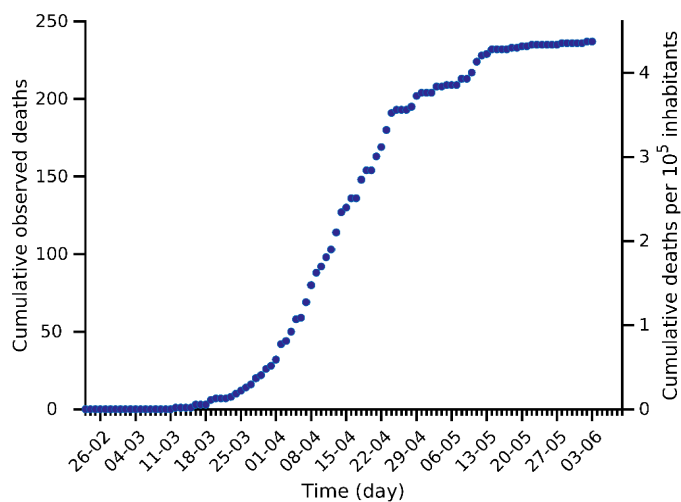
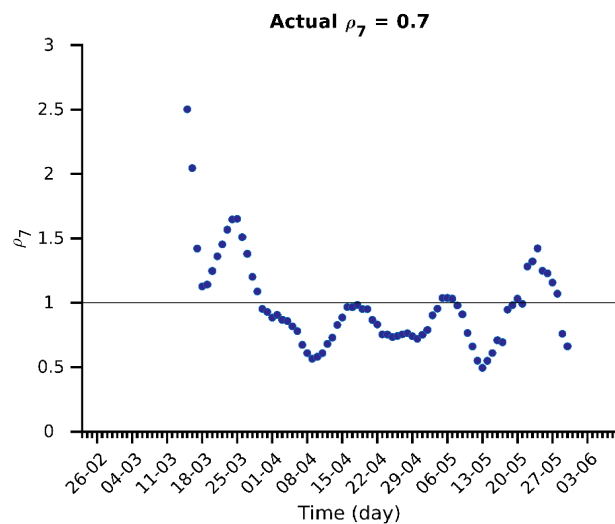
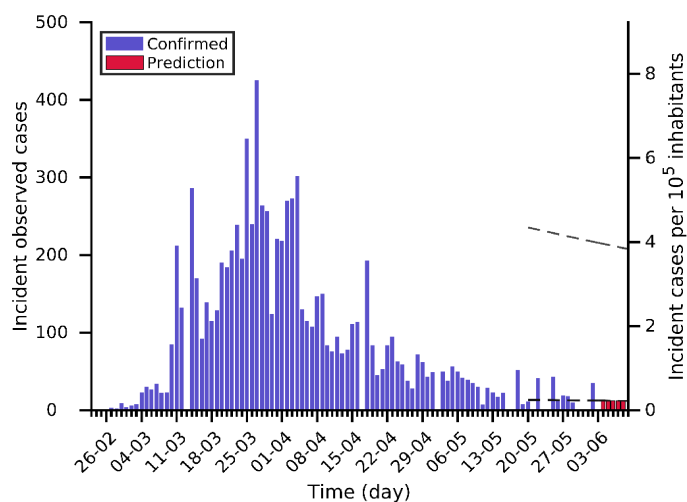
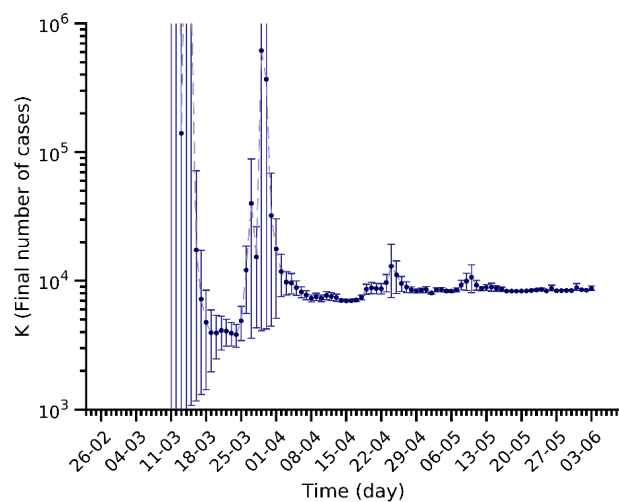
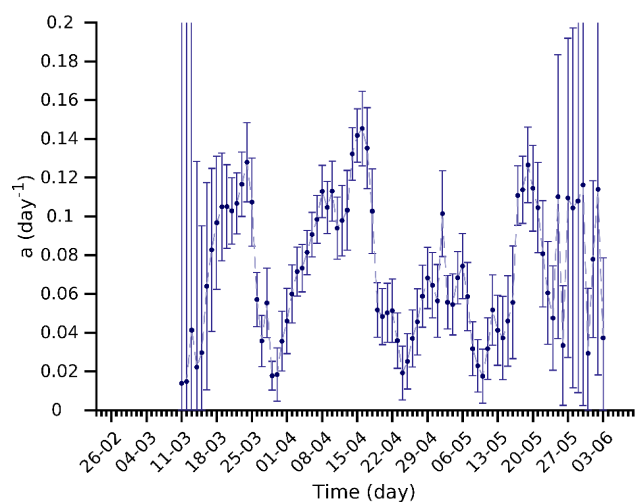
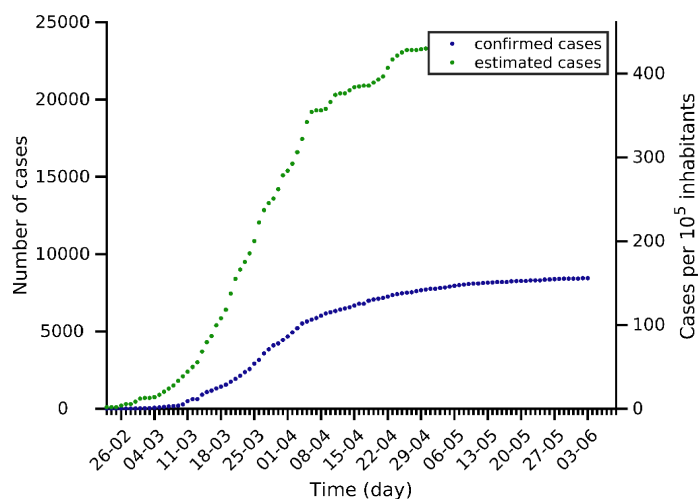
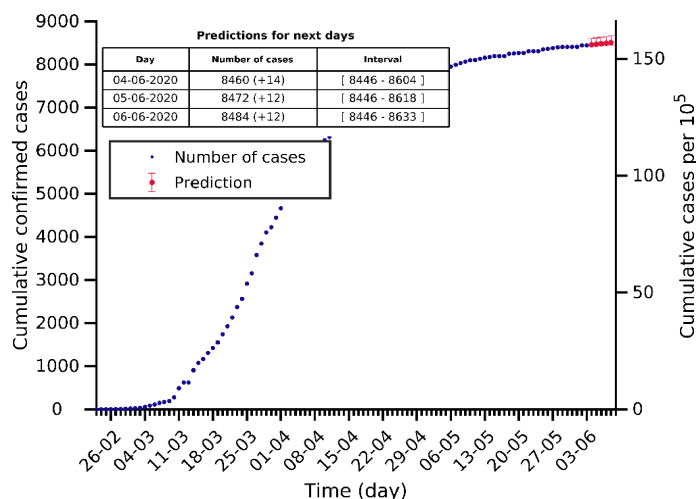
# Denmark 03-06-2020. Population: 5.8M. Current cumulated incidence: 203/10<sup>5</sup>



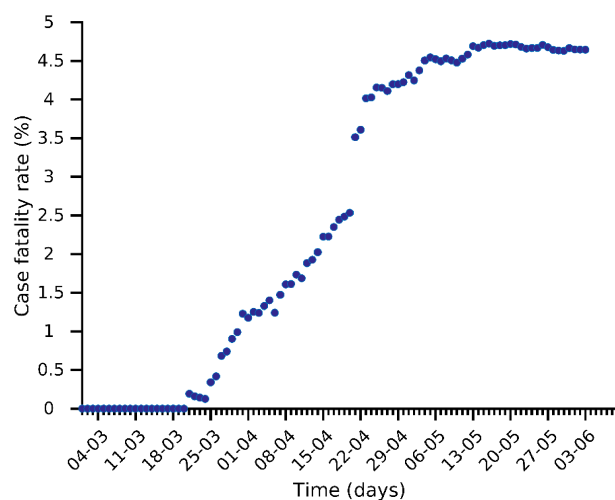
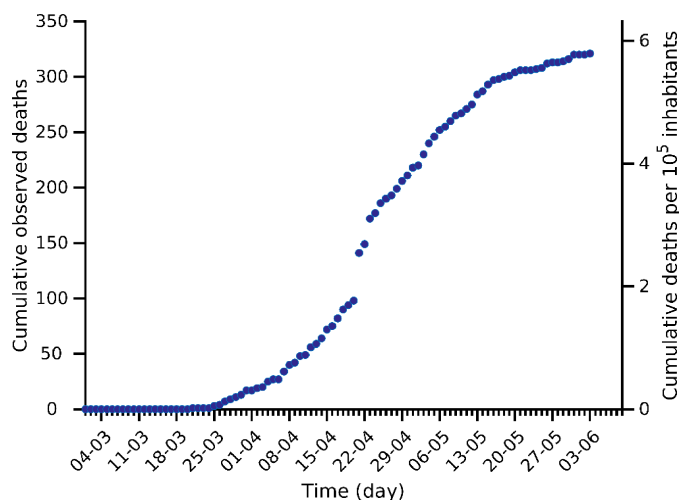
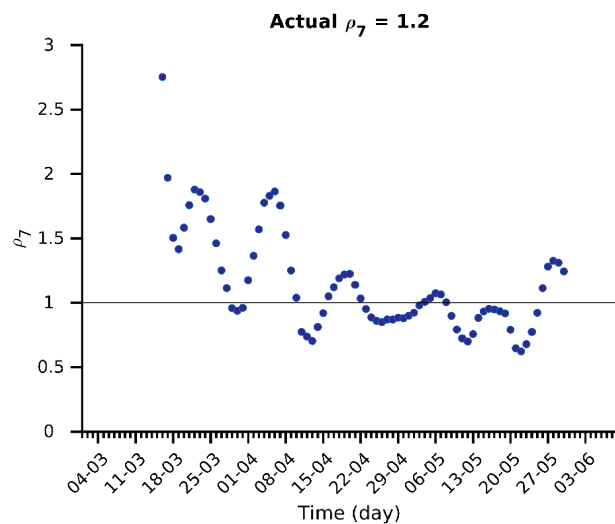
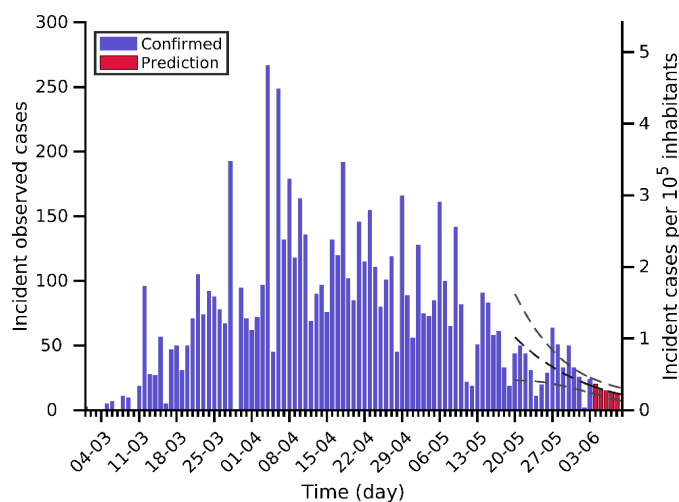
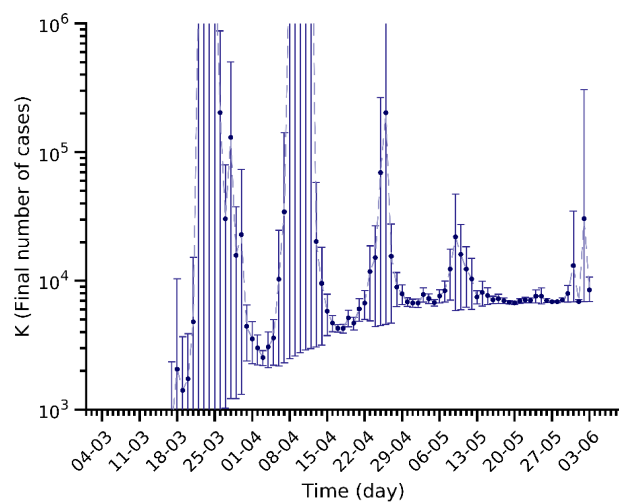
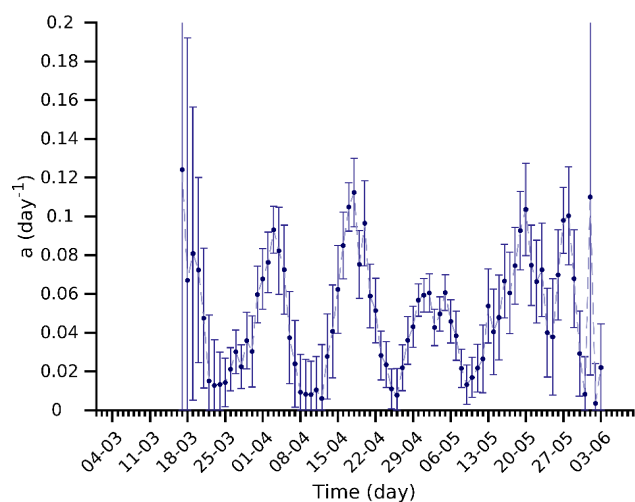
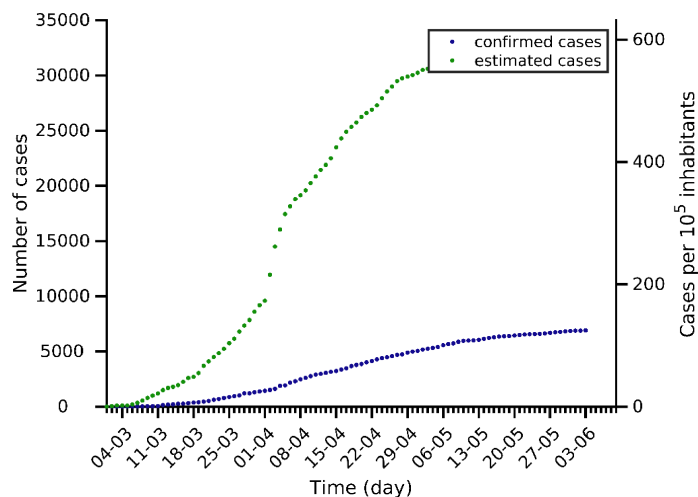
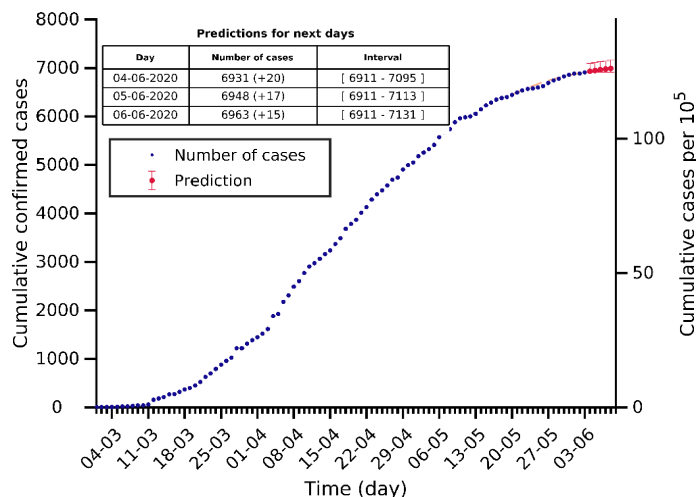




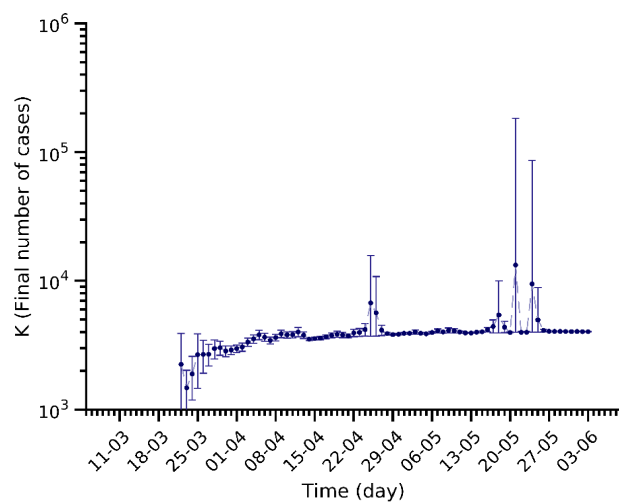
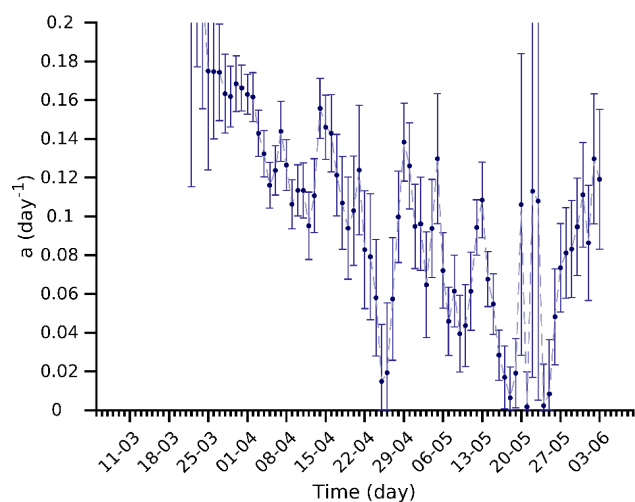
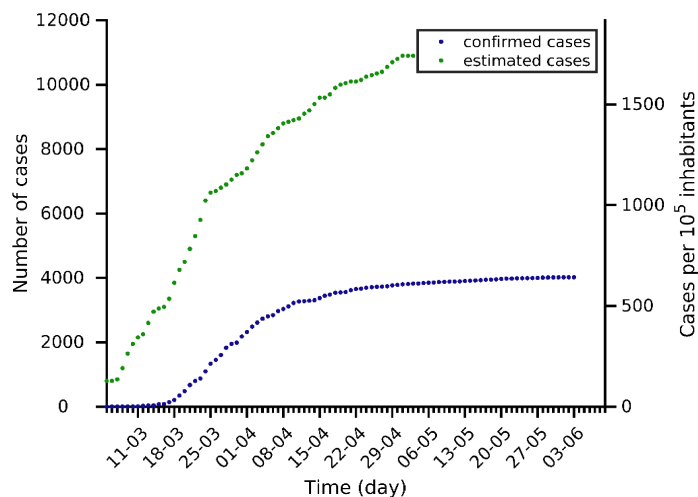
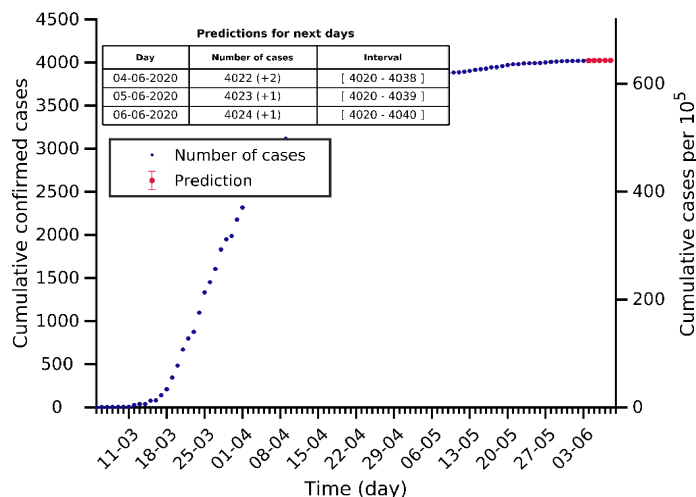
# Norway 03-06-2020. Population: 5.4M. Current cumulated incidence: 156/10<sup>5</sup>



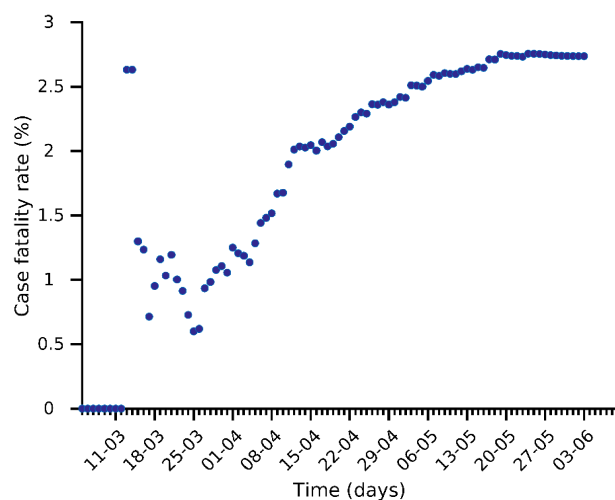
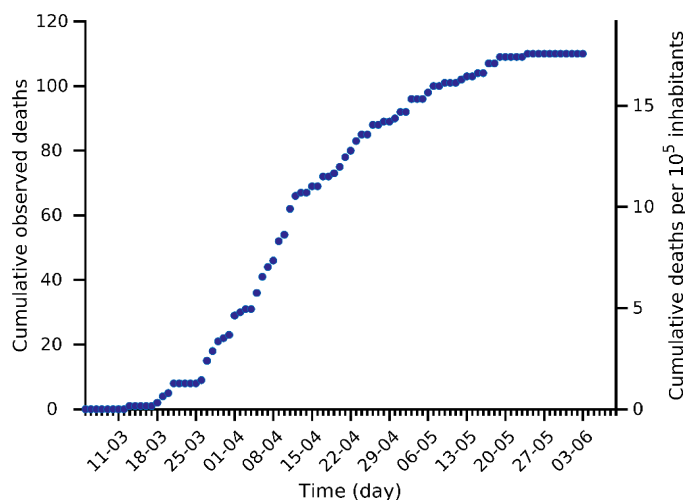
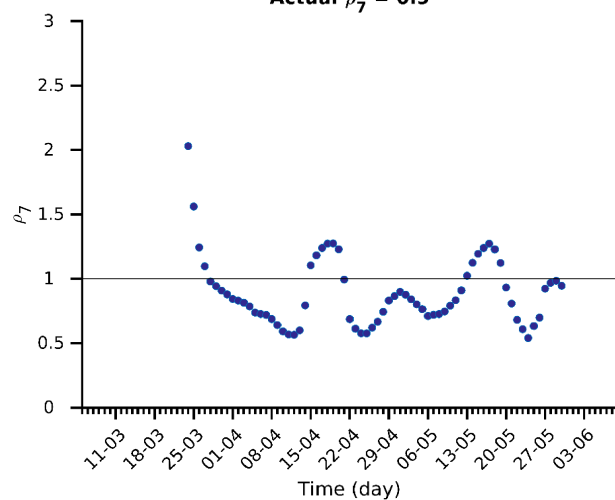
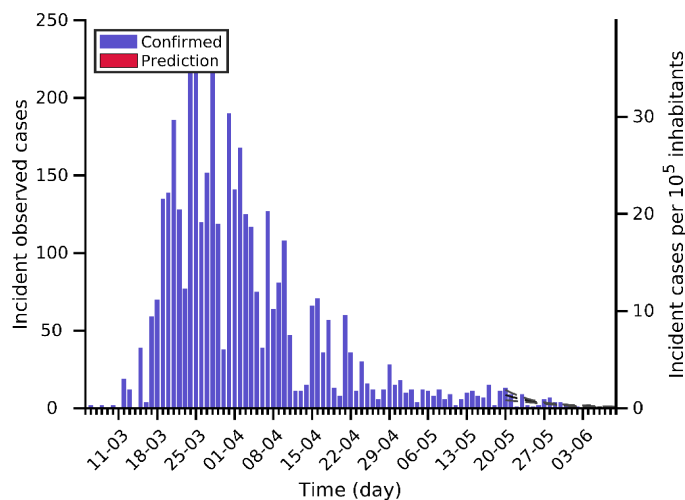
# Finland 03-06-2020. Population: 5.5M. Current cumulated incidence: 125/10<sup>5</sup>



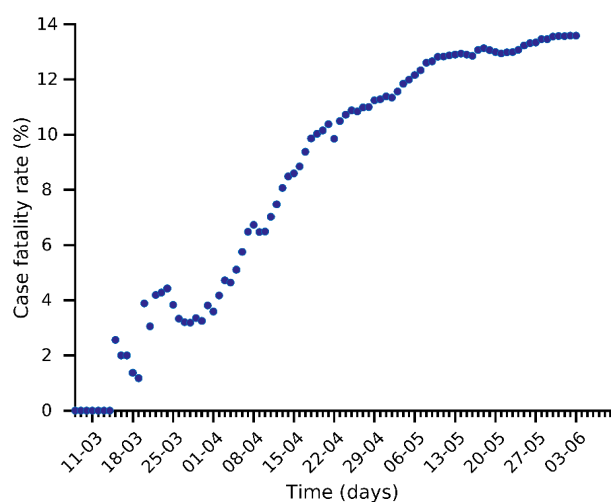
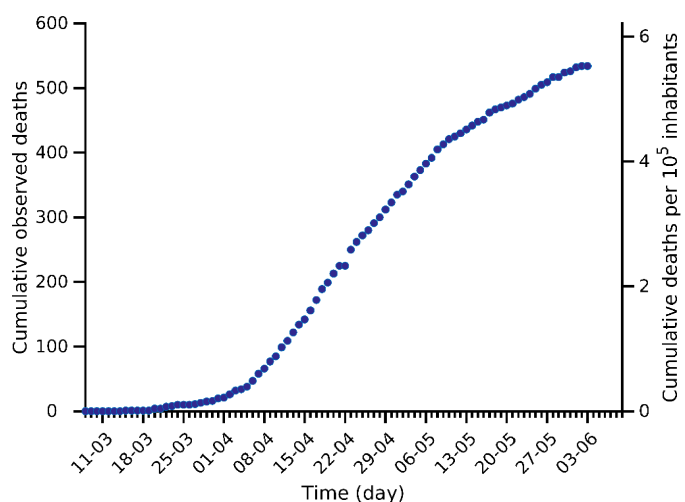
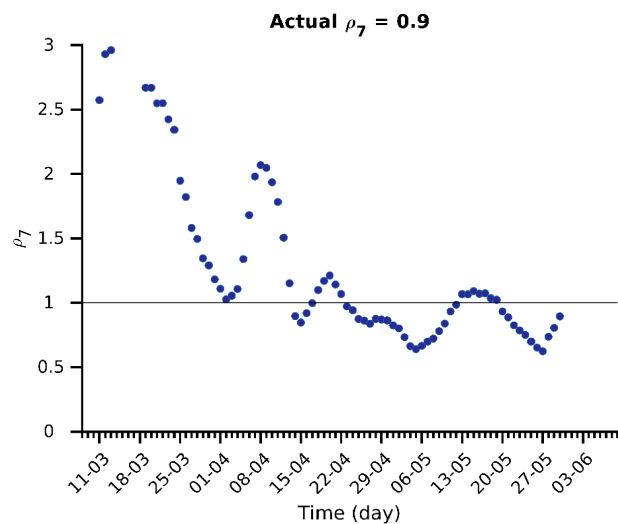
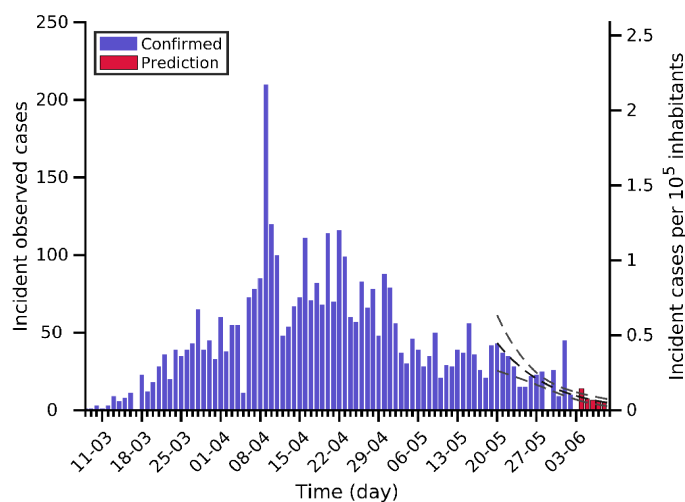
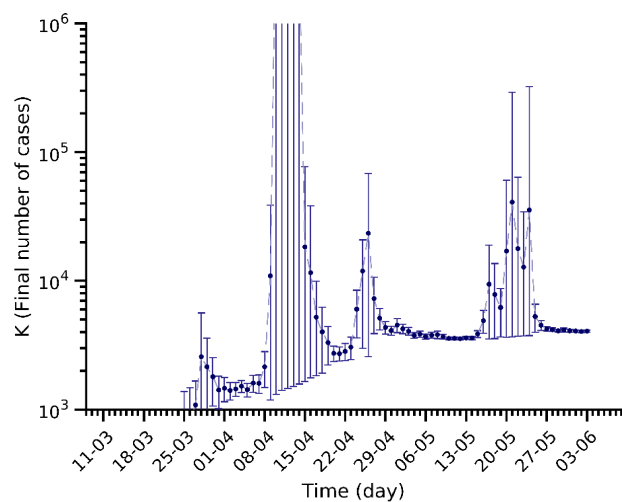
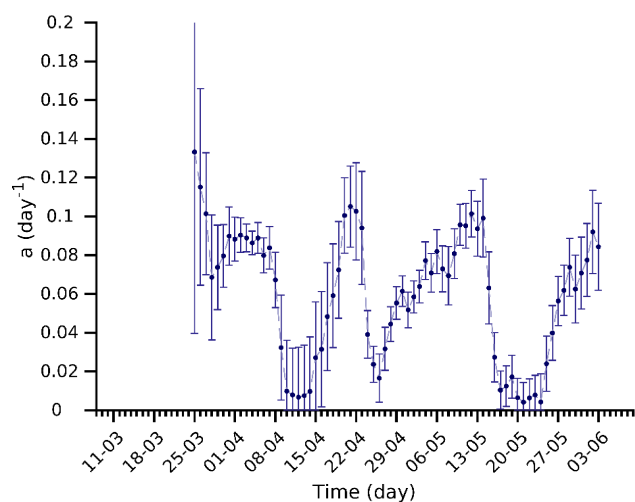
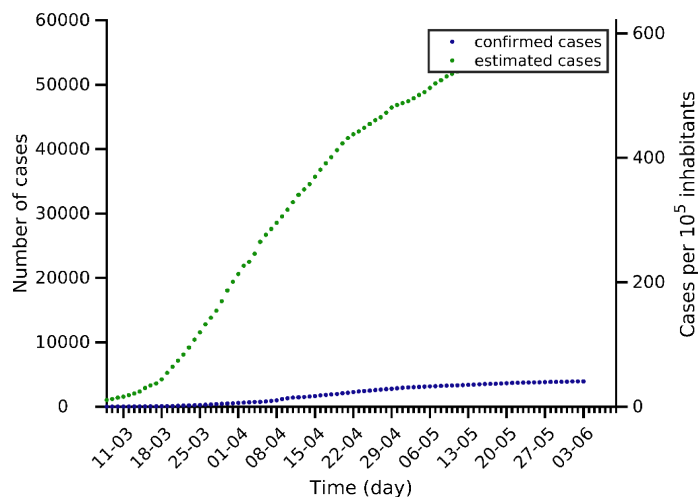
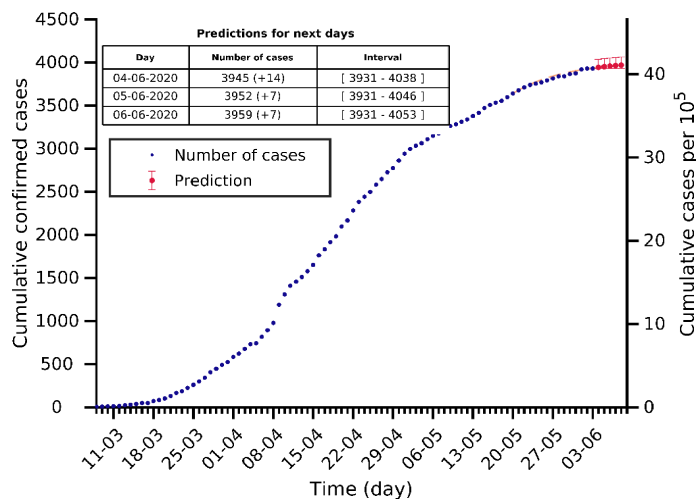
# Luxembourg 03-06-2020. Population: 0.6M. Current cumulated incidence: 642/10<sup>5</sup>



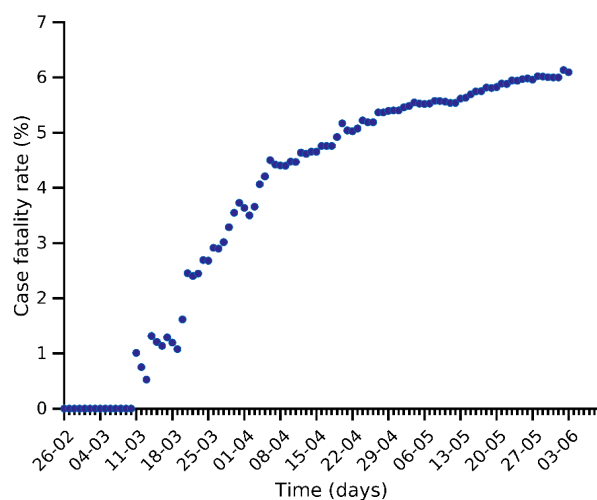
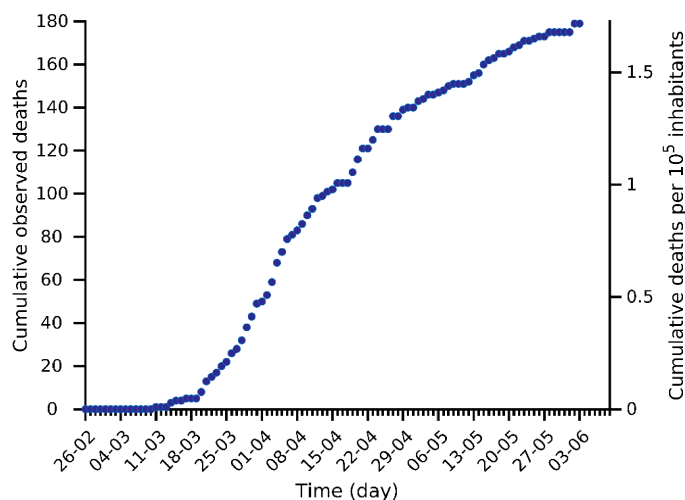
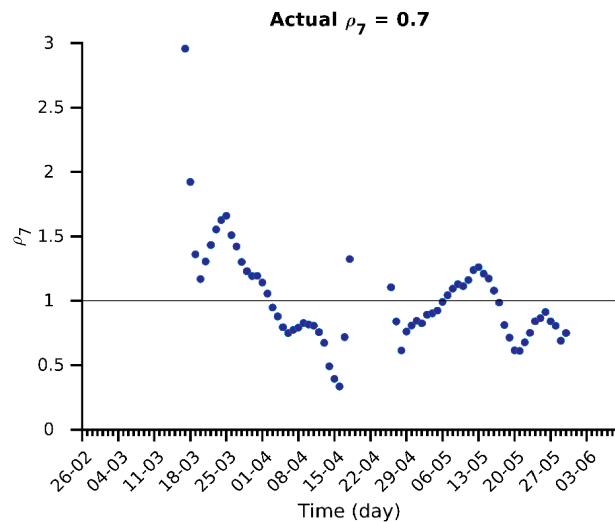
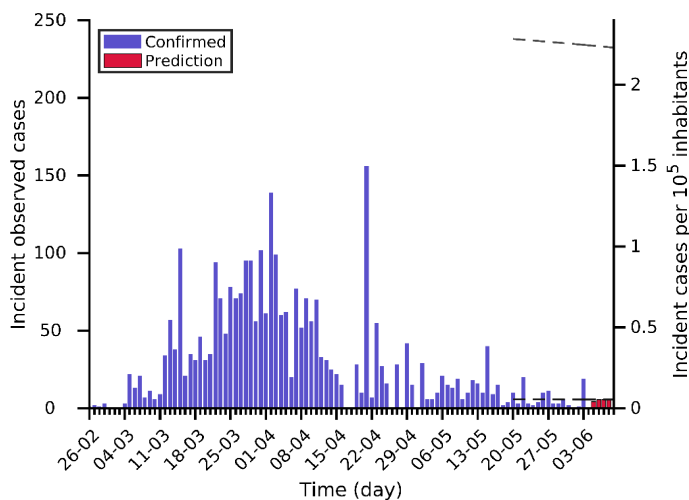
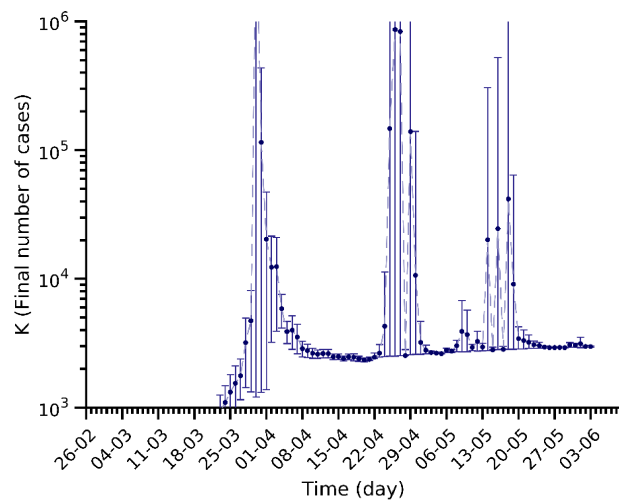
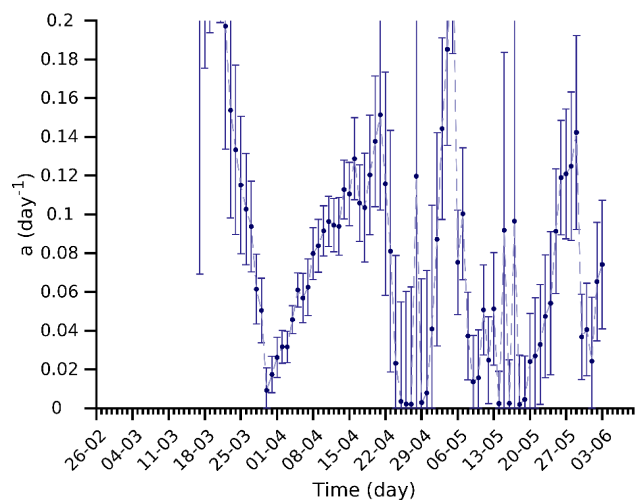
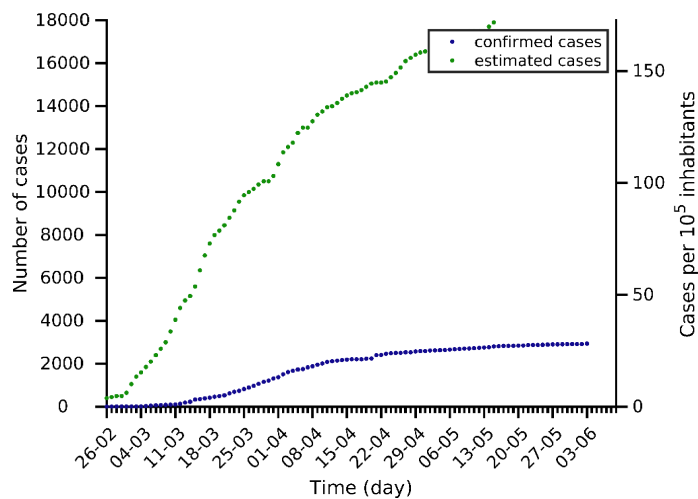
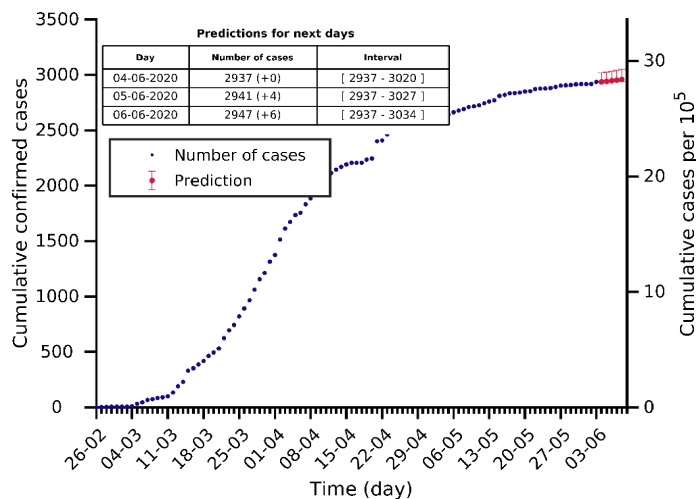
**Actual  $\rho_7 = 0.9$**



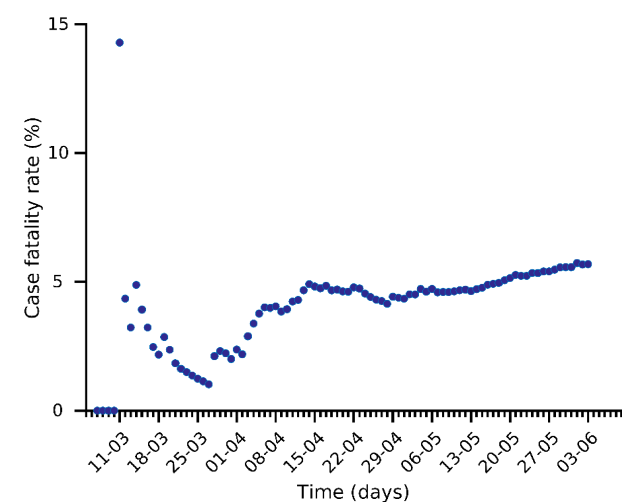
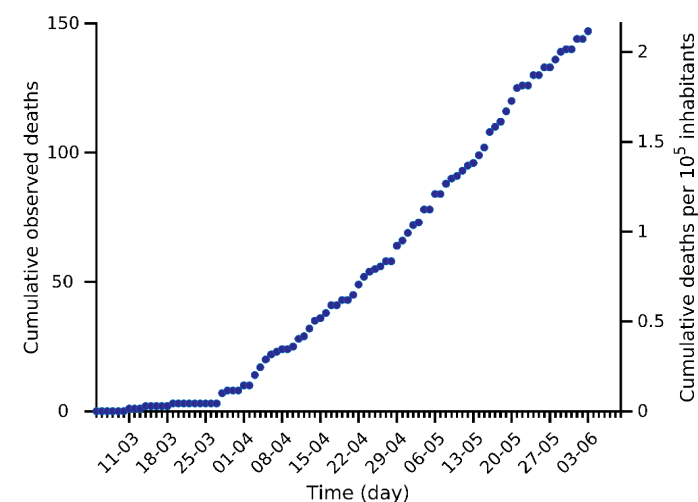
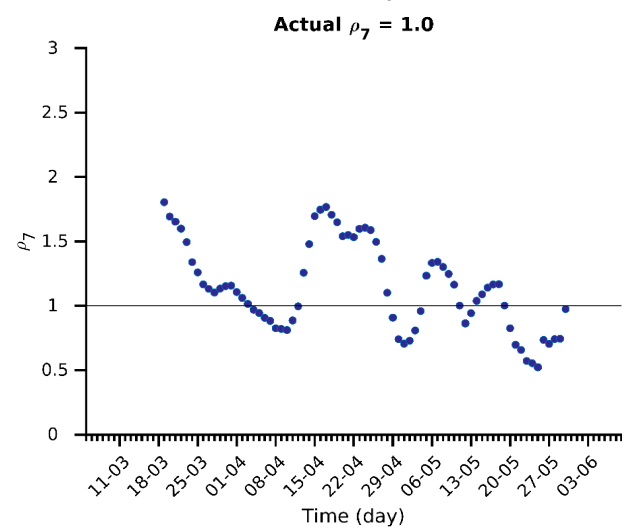
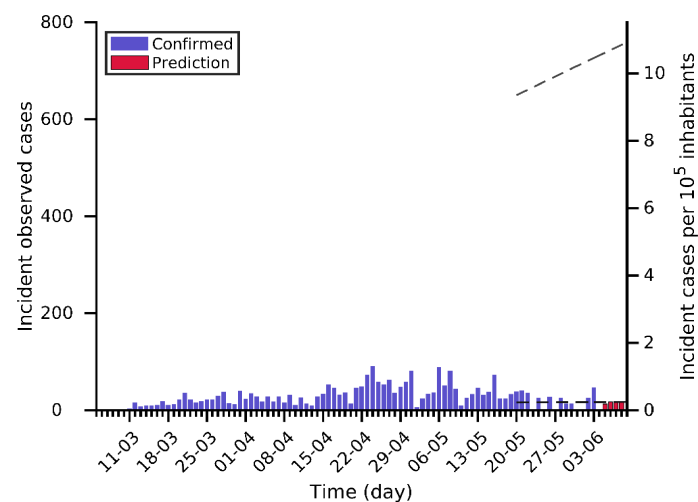
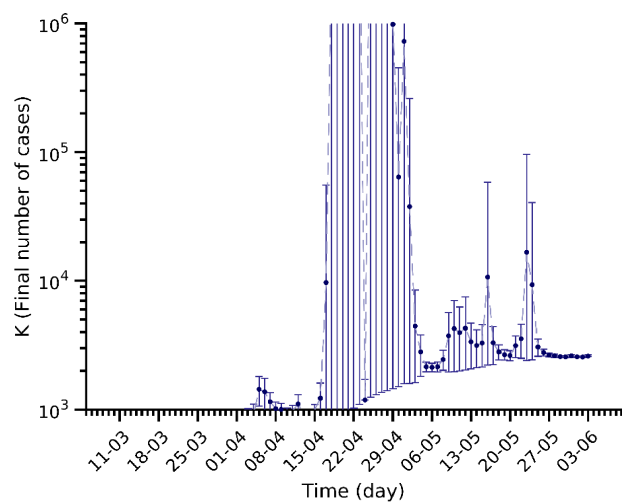
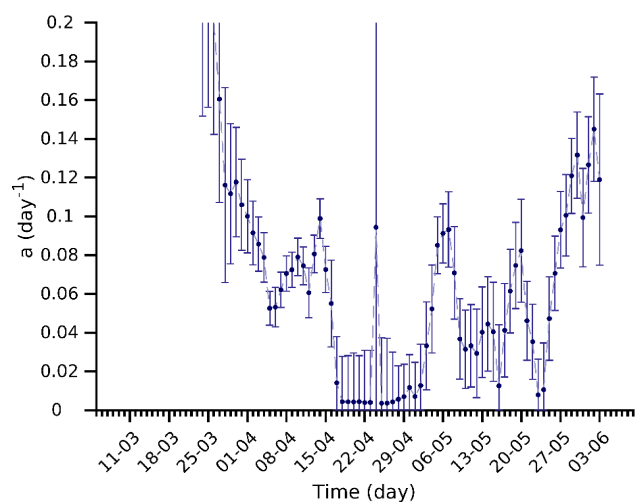
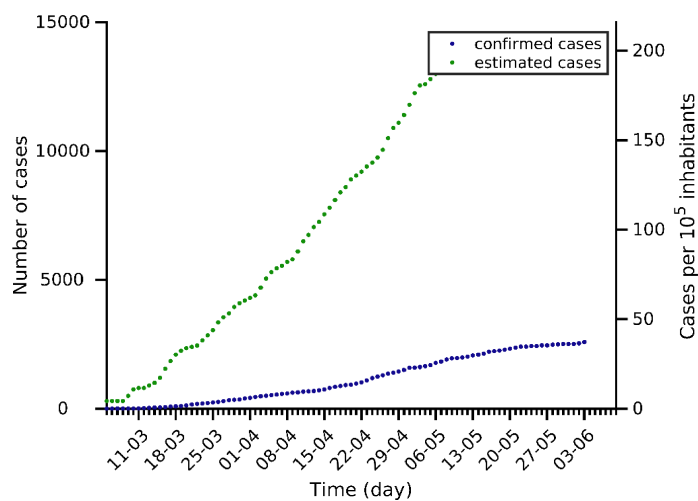
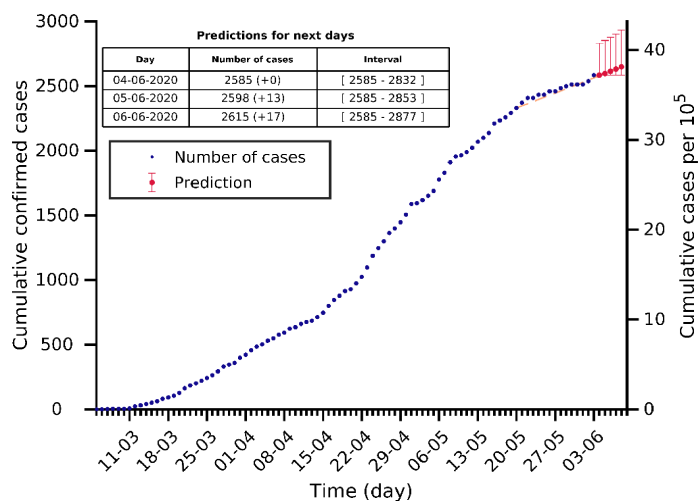
# Hungary 03-06-2020. Population: 9.7M. Current cumulated incidence: 41/10<sup>5</sup>



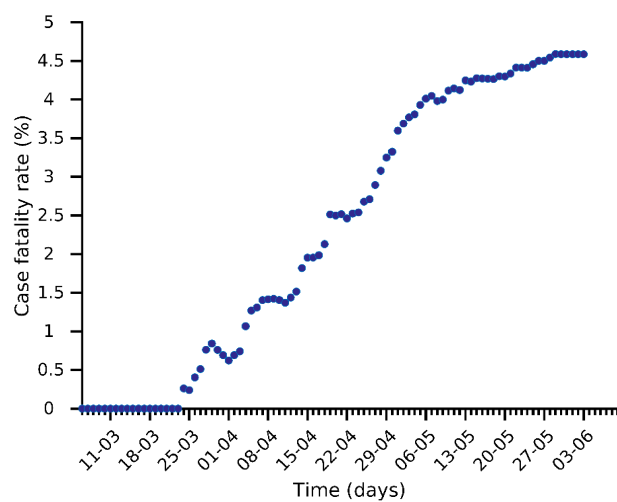
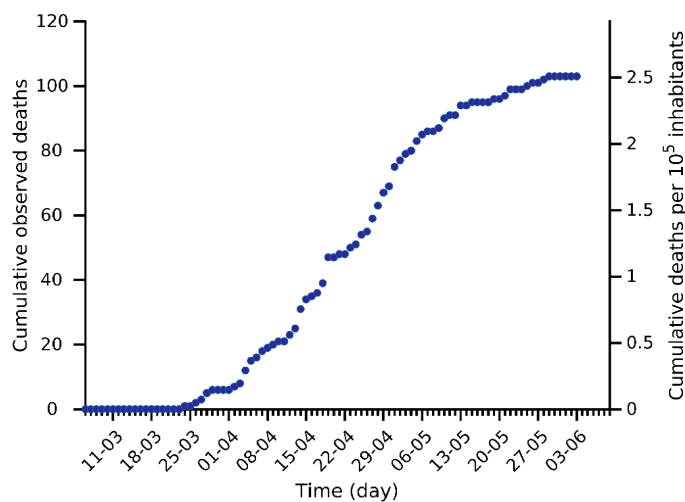
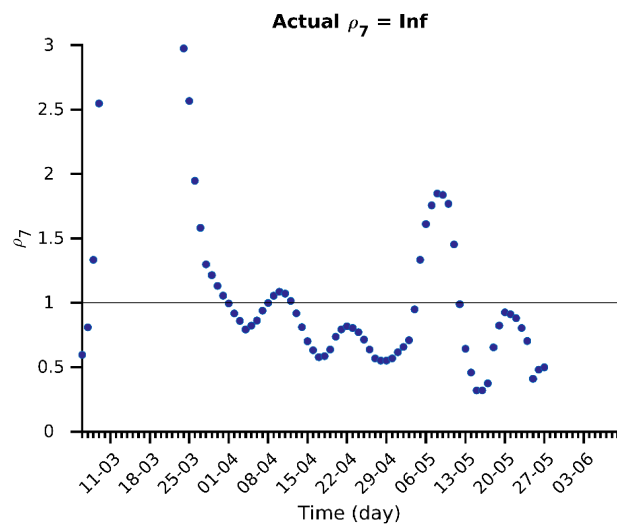
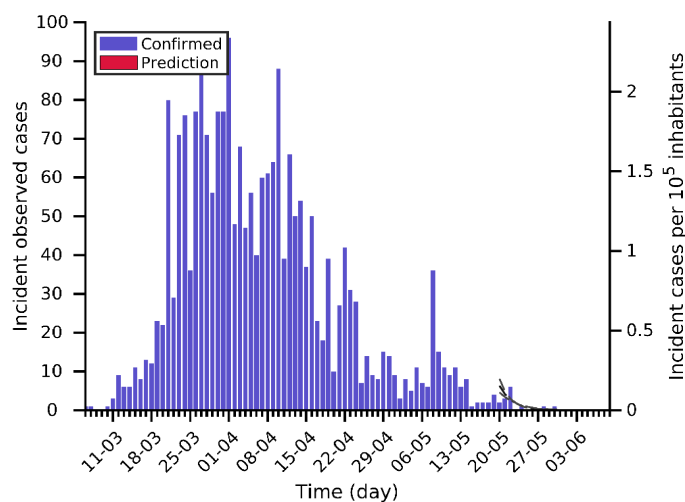
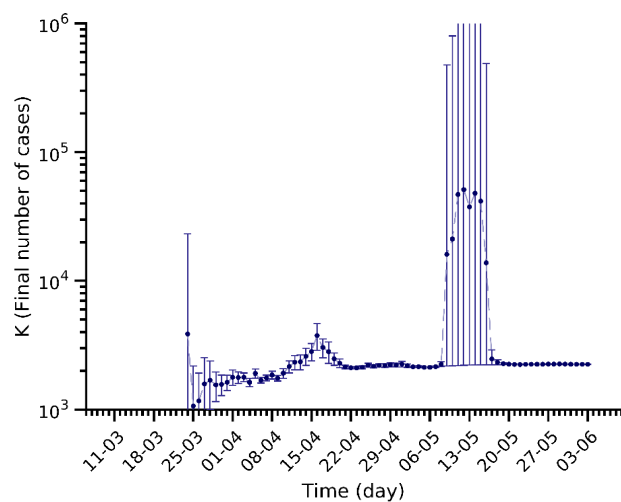
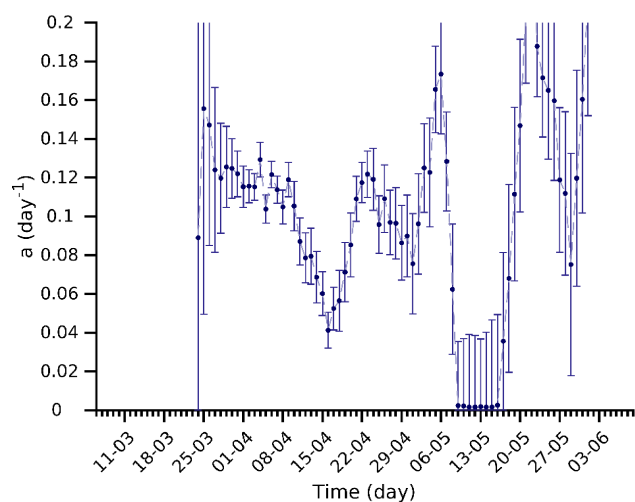
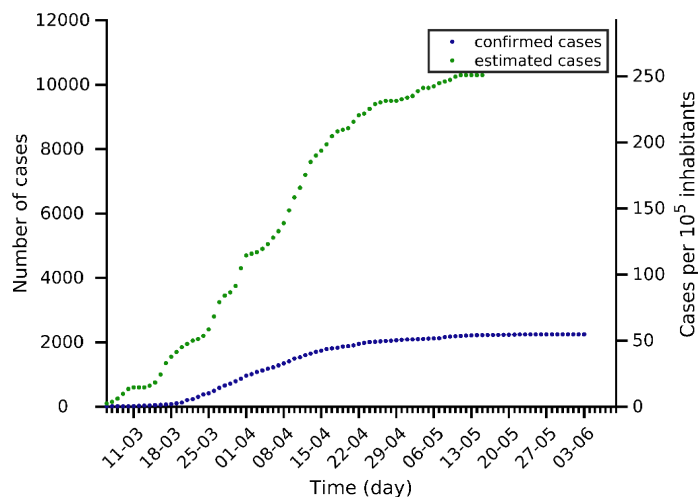
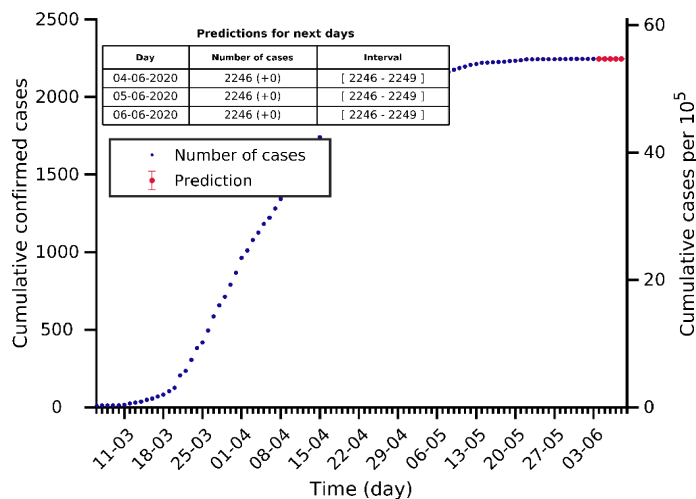
# Greece 03-06-2020. Population: 10.4M. Current cumulated incidence: 28/10<sup>5</sup>



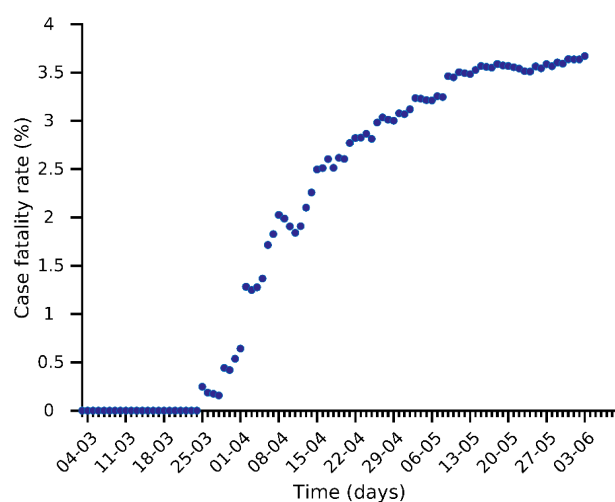
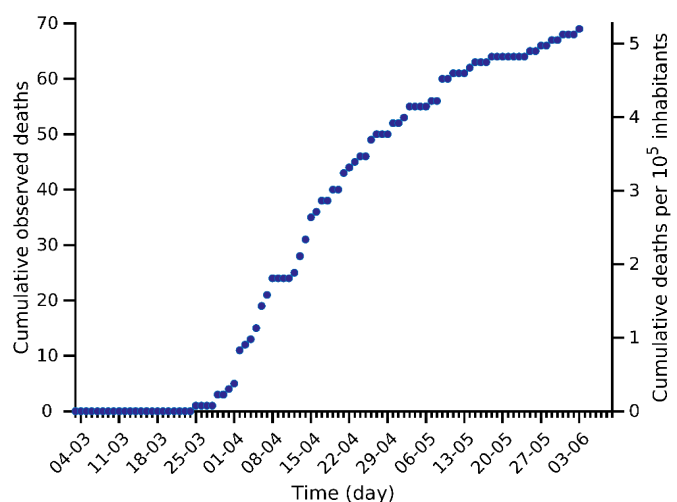
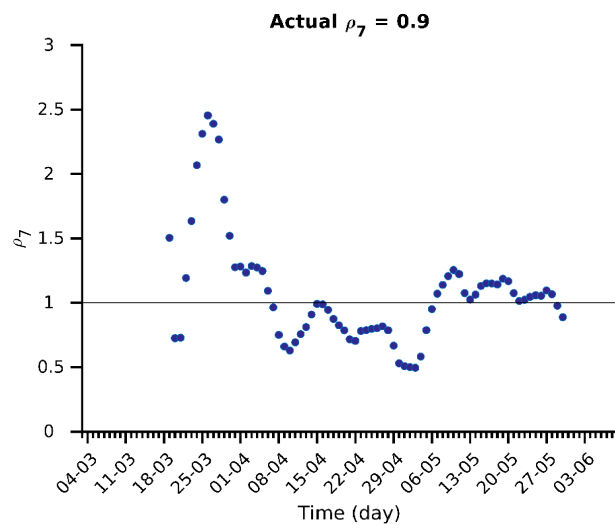
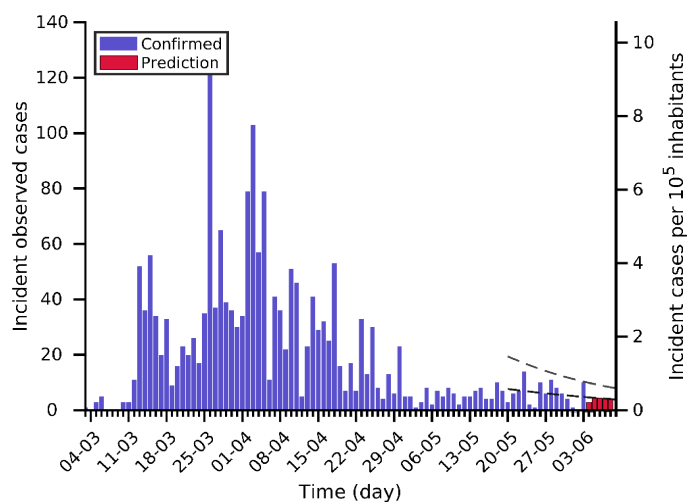
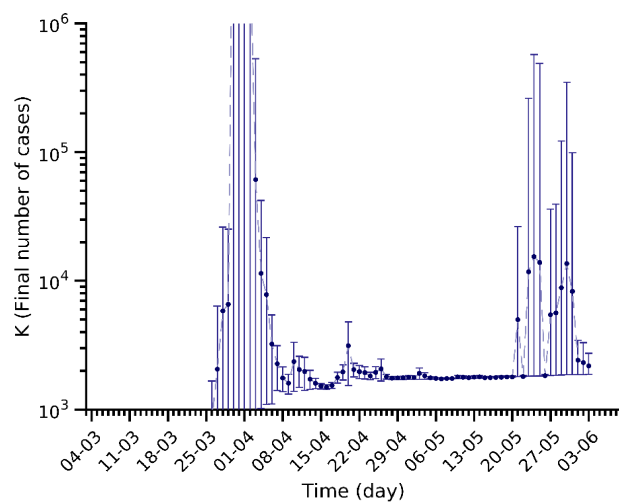
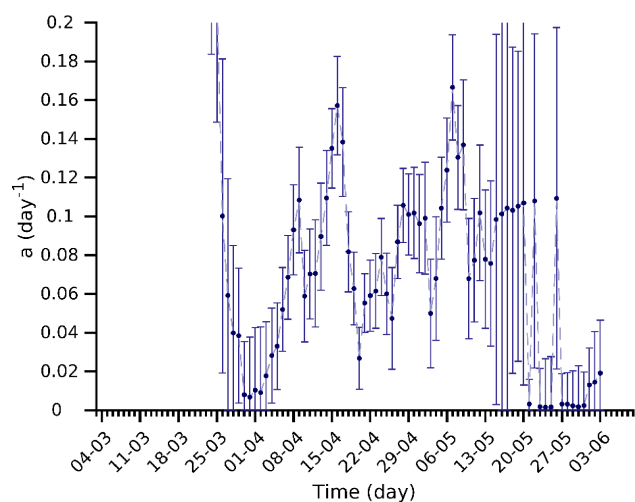
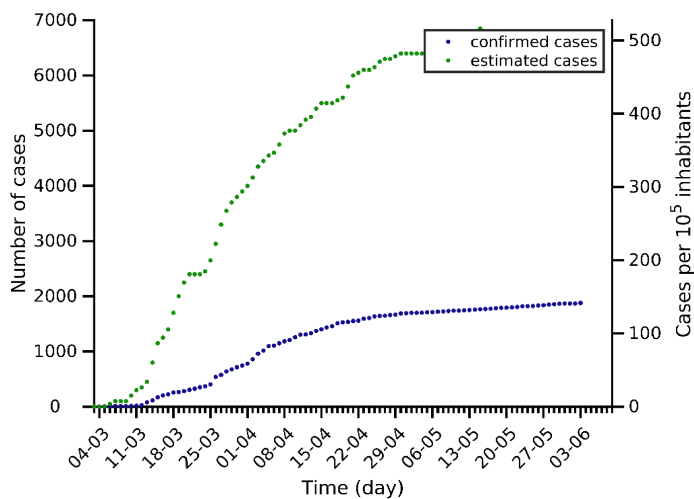
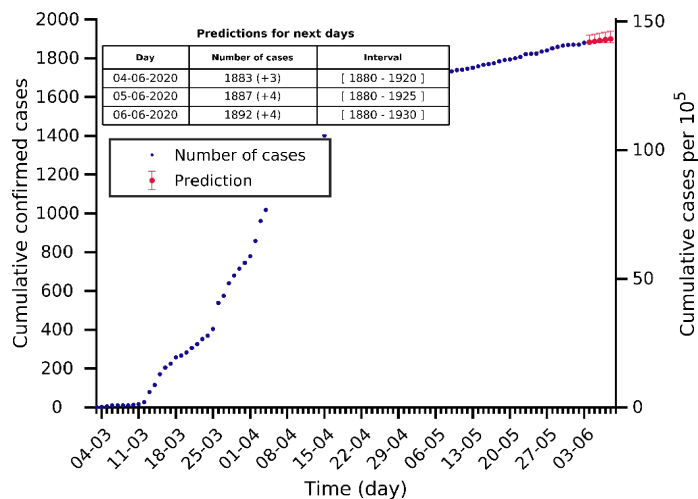
# Bulgaria 03-06-2020. Population: 6.9M. Current cumulated incidence: 37/10<sup>5</sup>



# Croatia 03-06-2020. Population: 4.1M. Current cumulated incidence: 55/10<sup>5</sup>

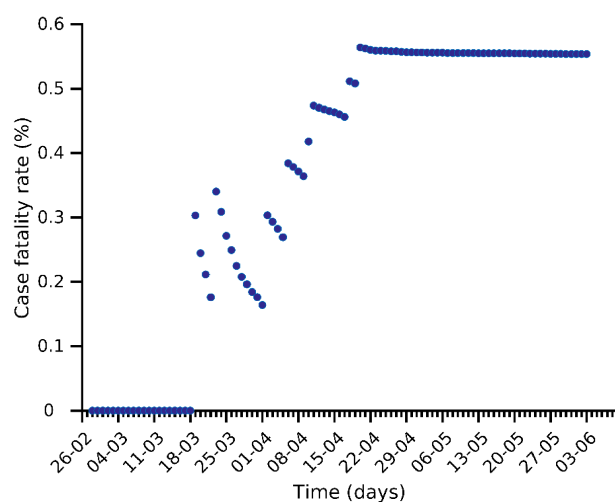
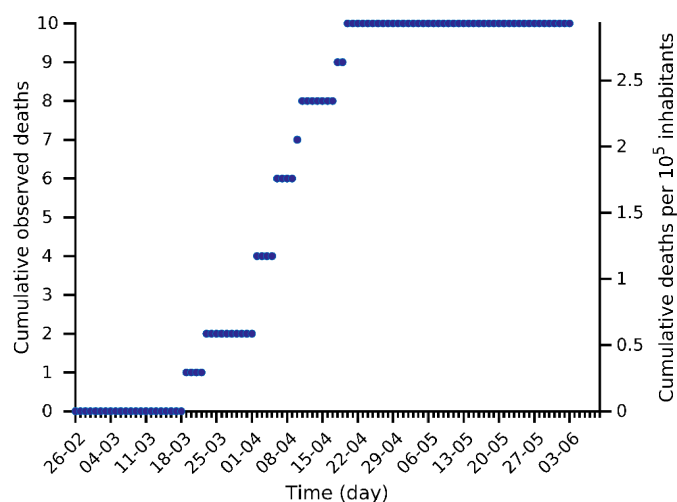
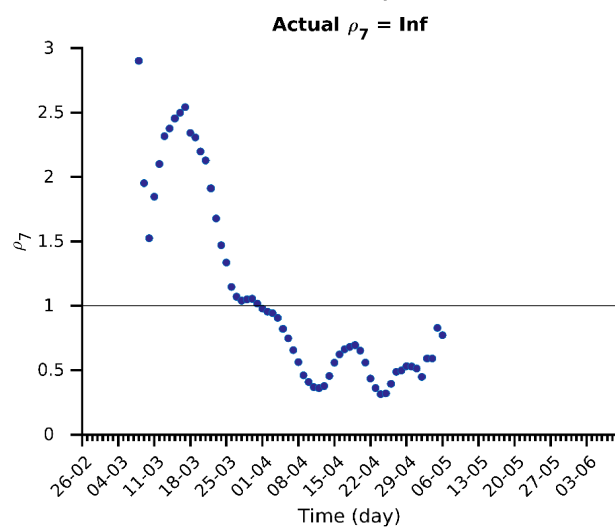
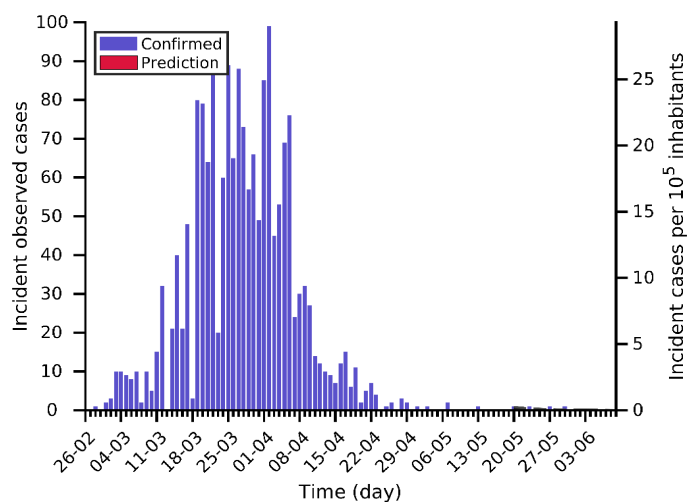
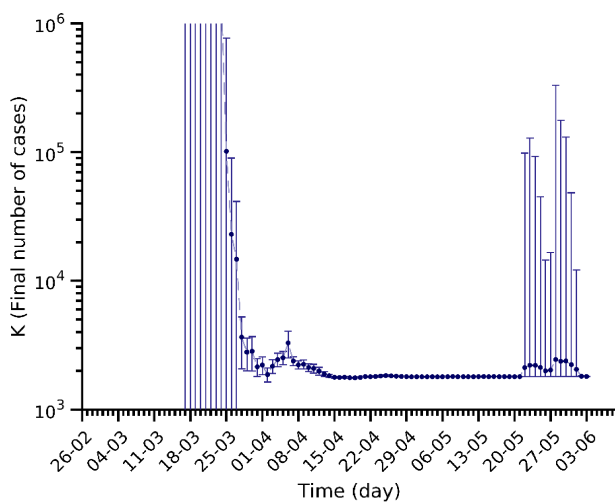
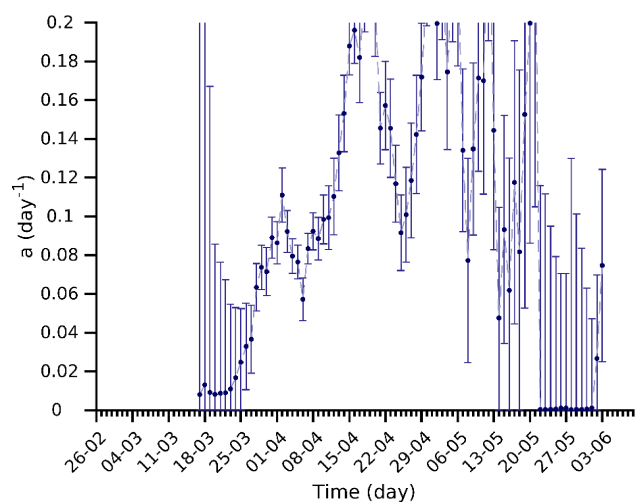
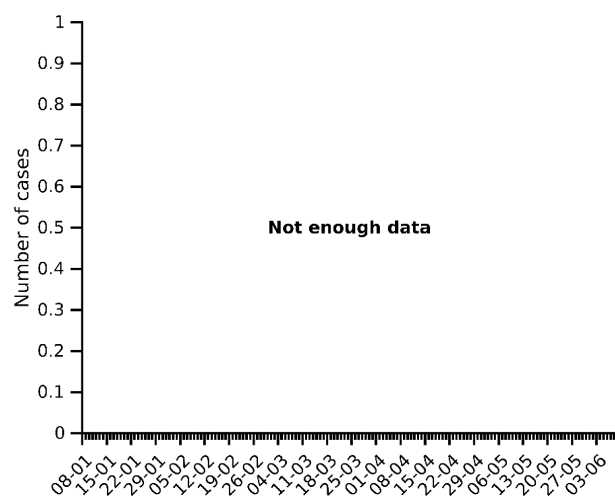
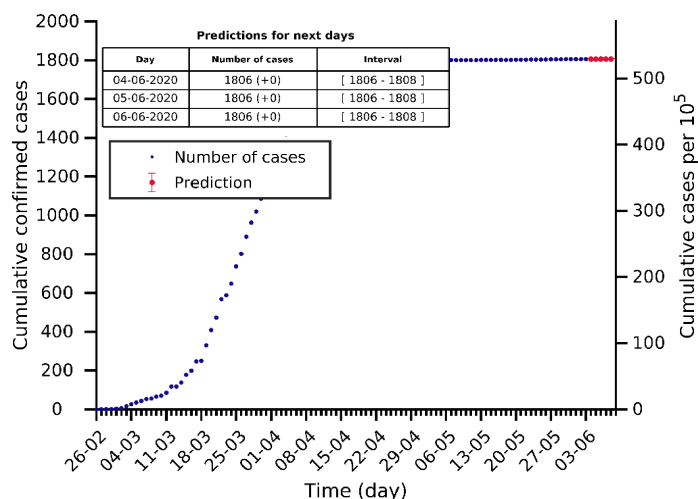


# Estonia 03-06-2020. Population: 1.3M. Current cumulated incidence: 142/10<sup>5</sup>

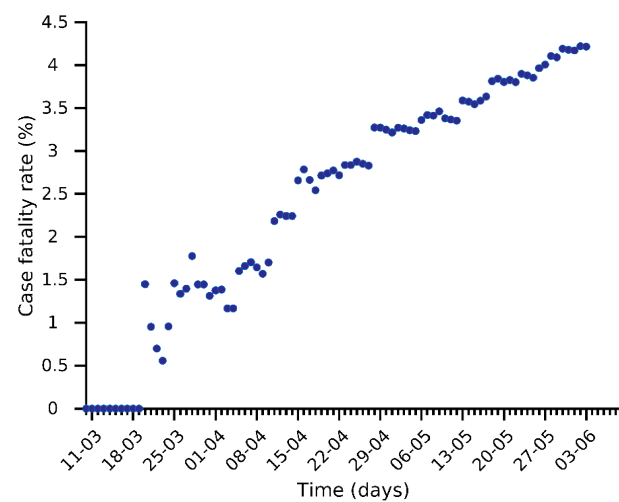
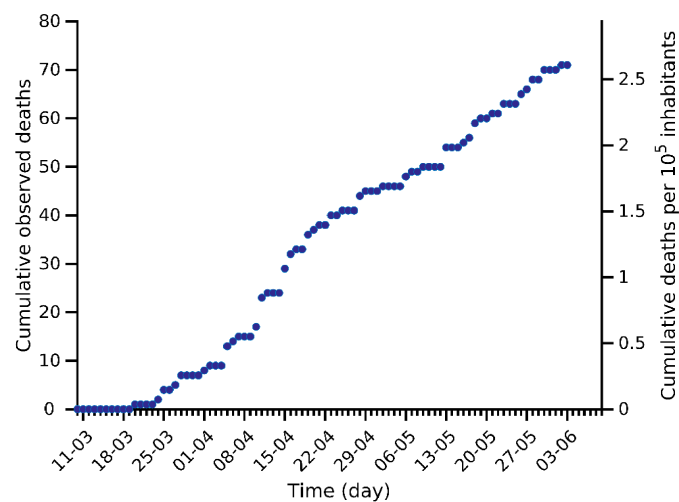
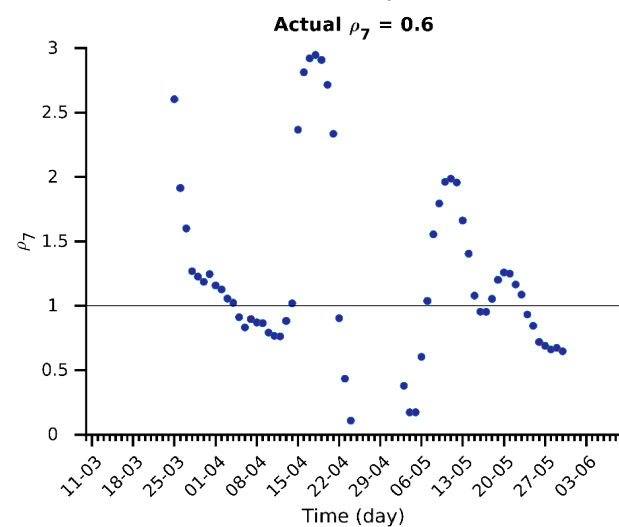
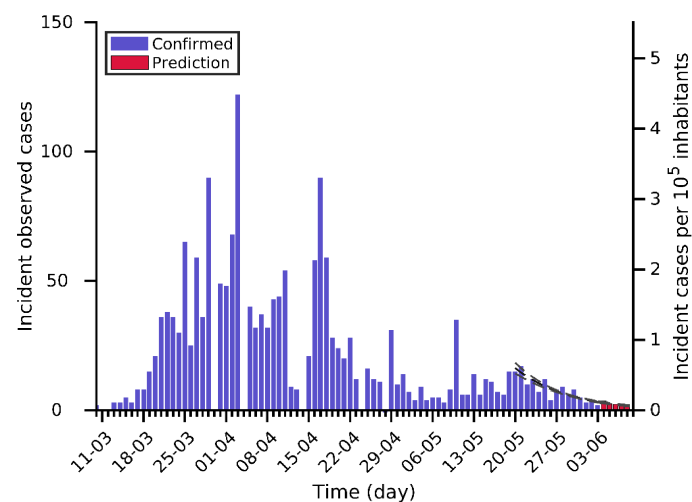
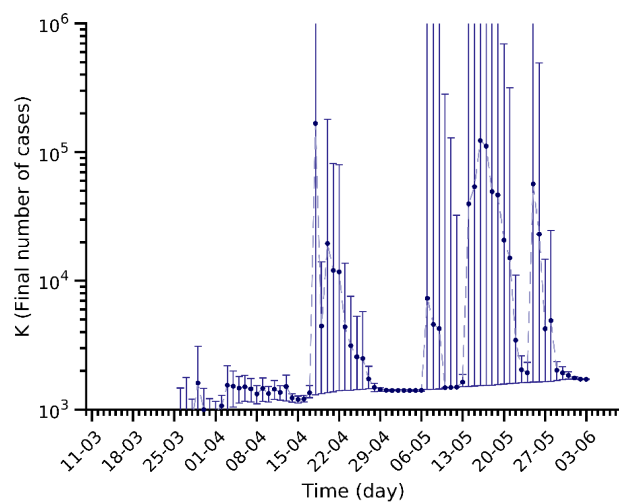
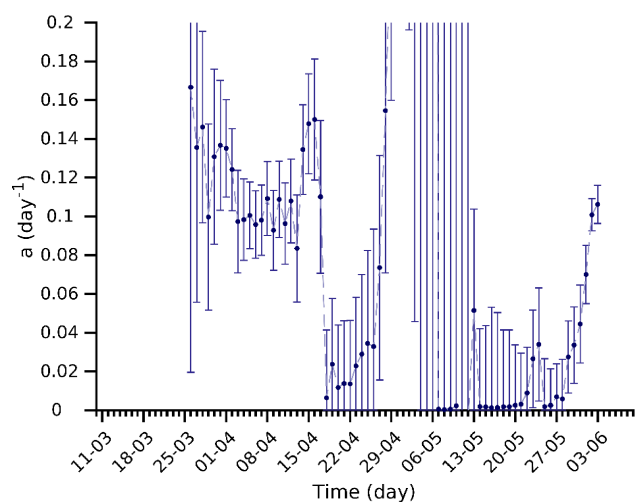
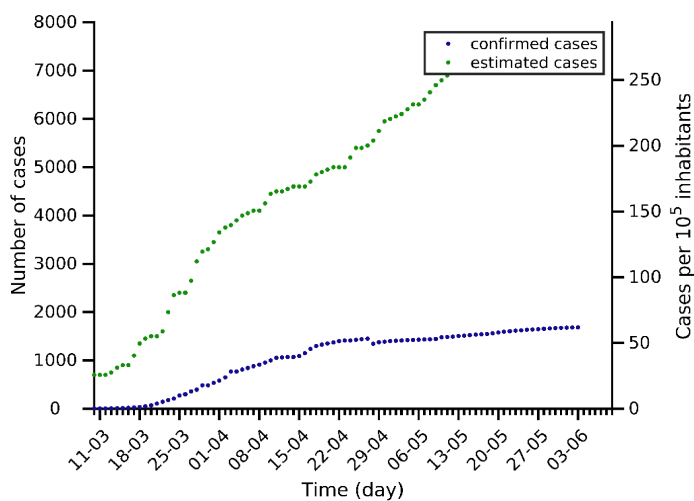
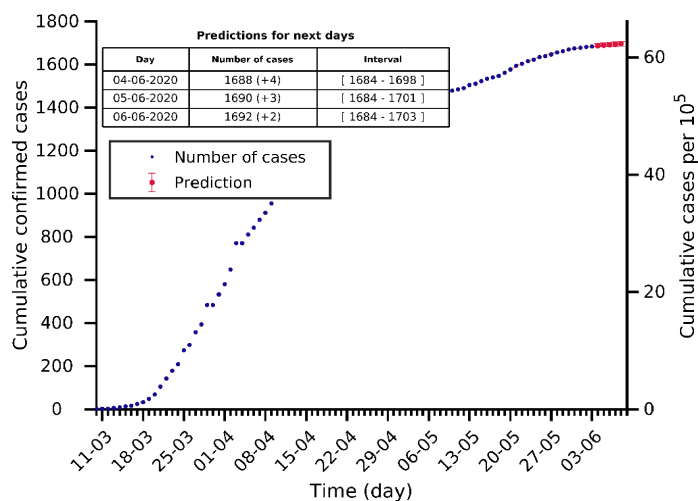




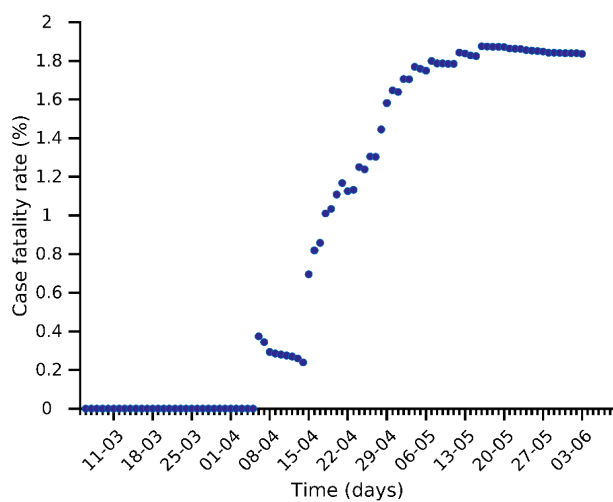
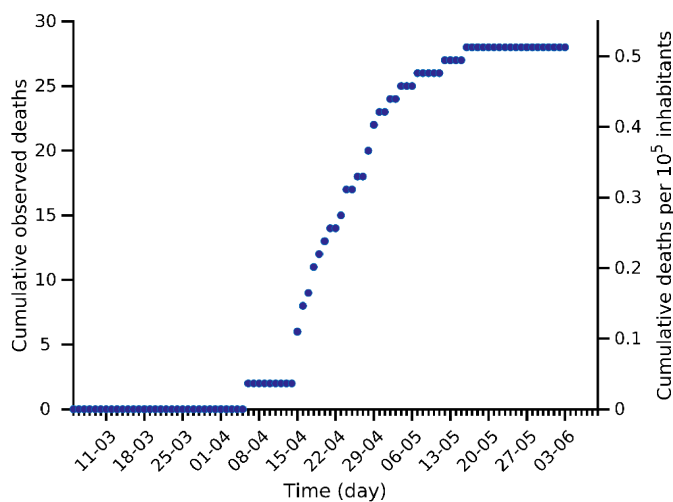
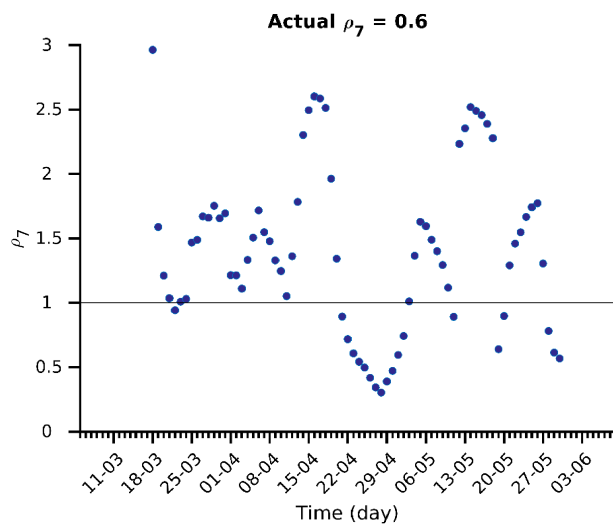
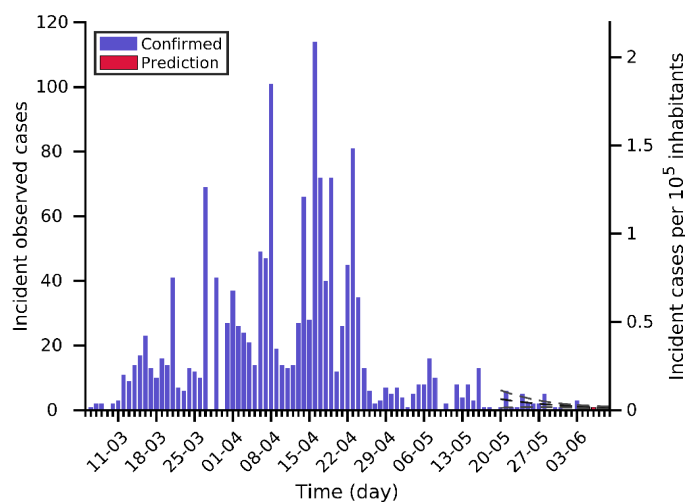
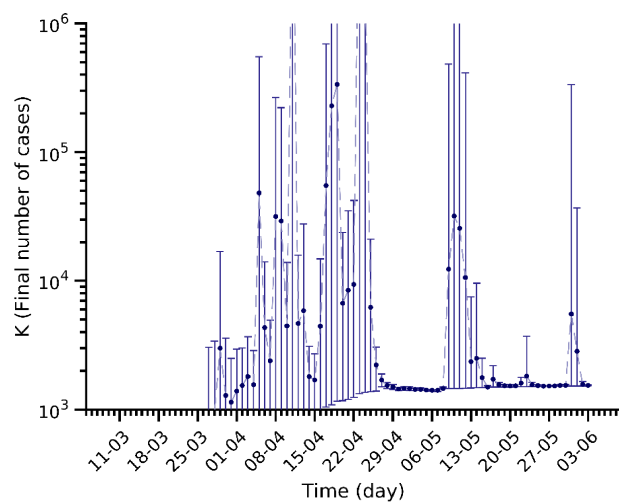
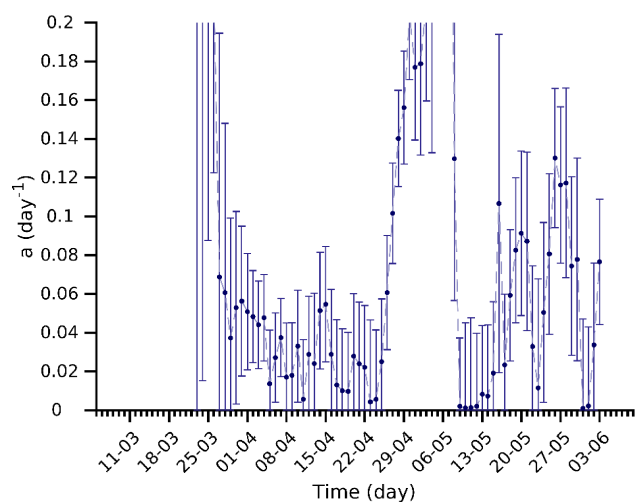
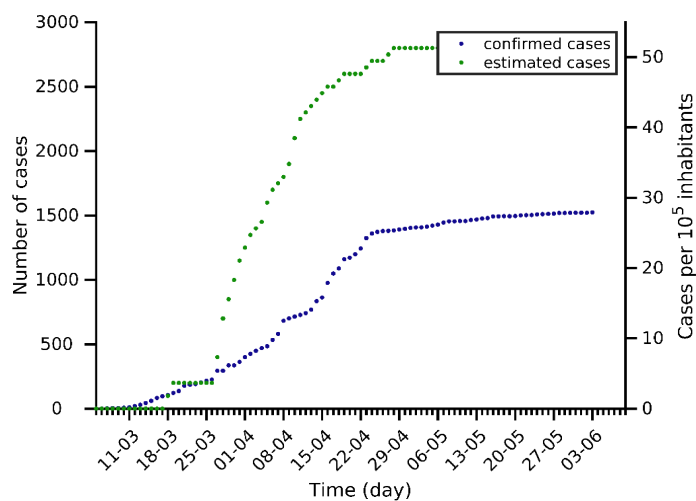
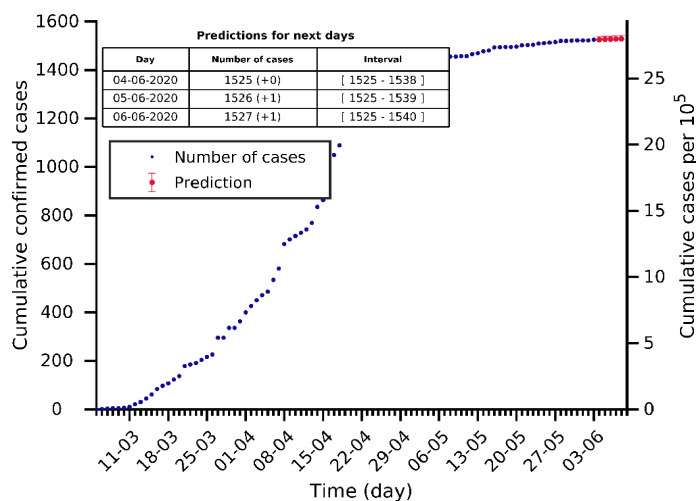
# Iceland 03-06-2020. Population: 0.3M. Current cumulated incidence: 529/10<sup>5</sup>



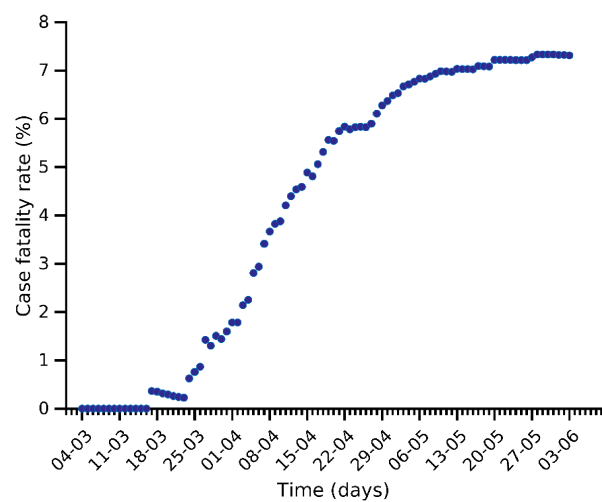
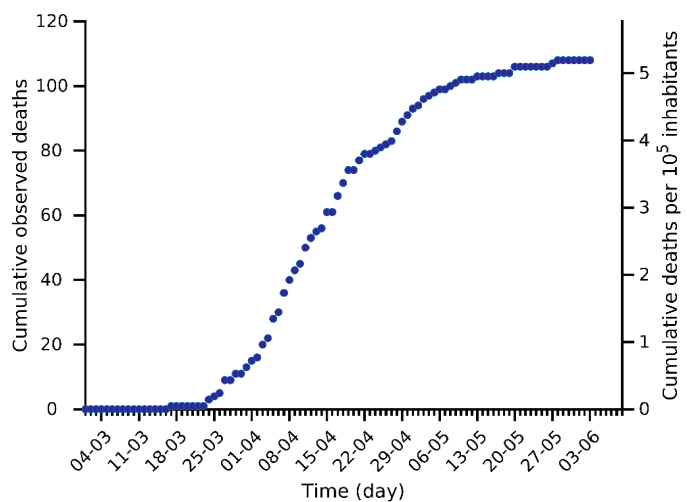
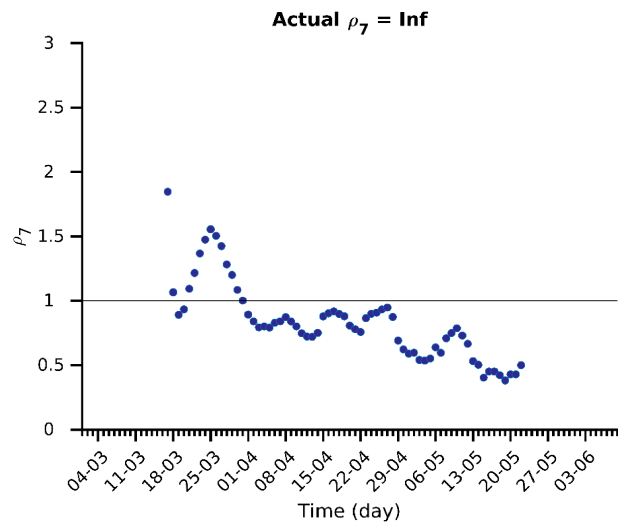
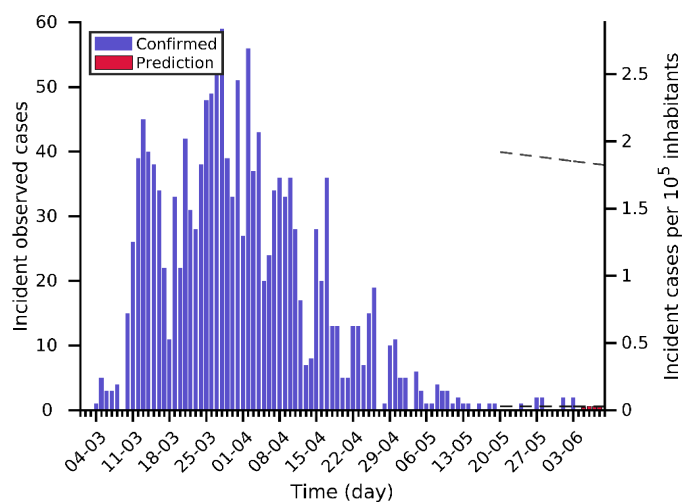
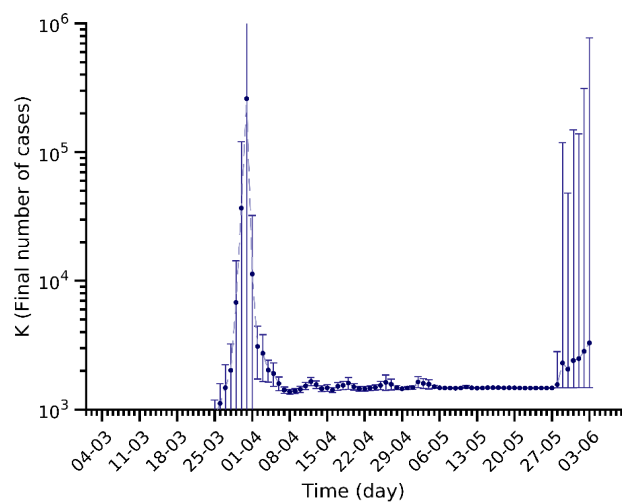
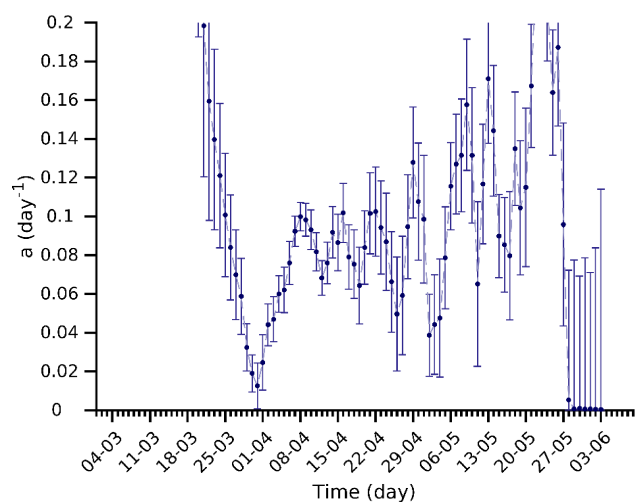
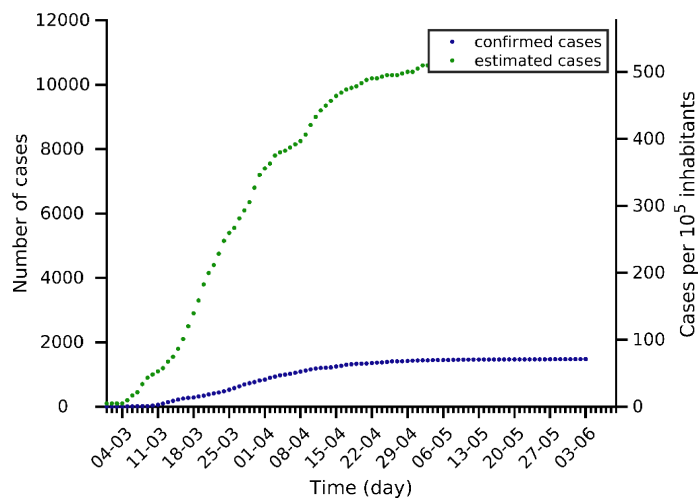
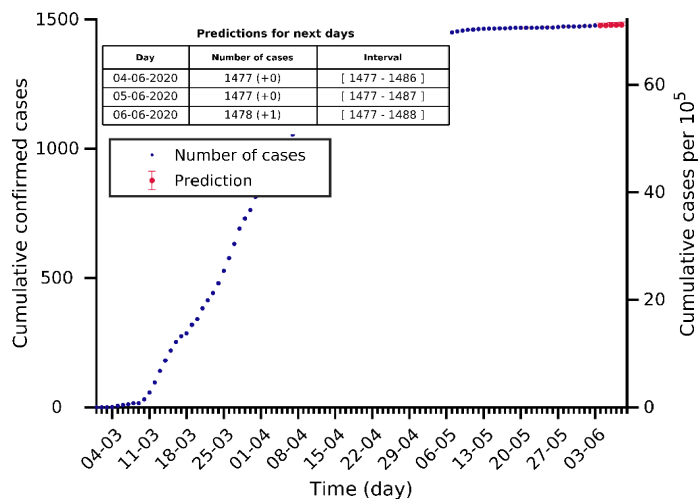
# Lithuania 03-06-2020. Population: 2.7M. Current cumulated incidence: 62/10<sup>5</sup>



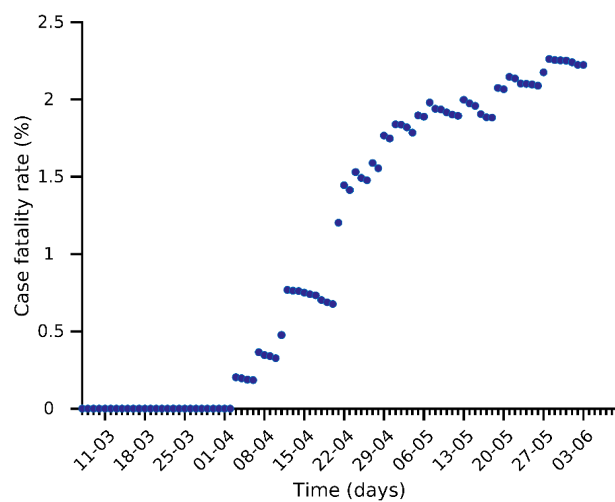
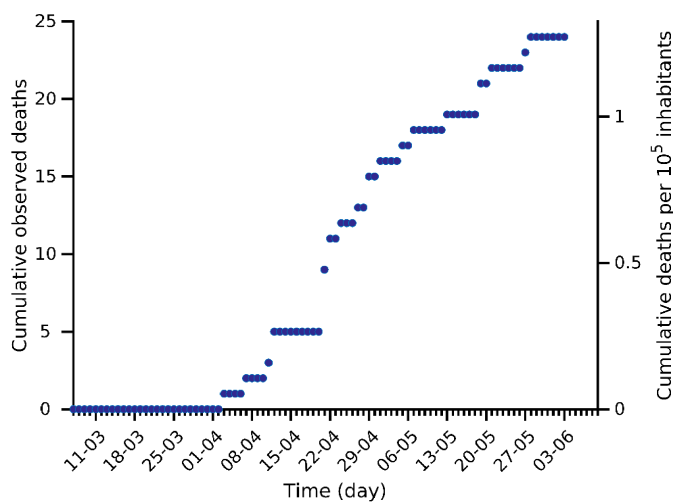
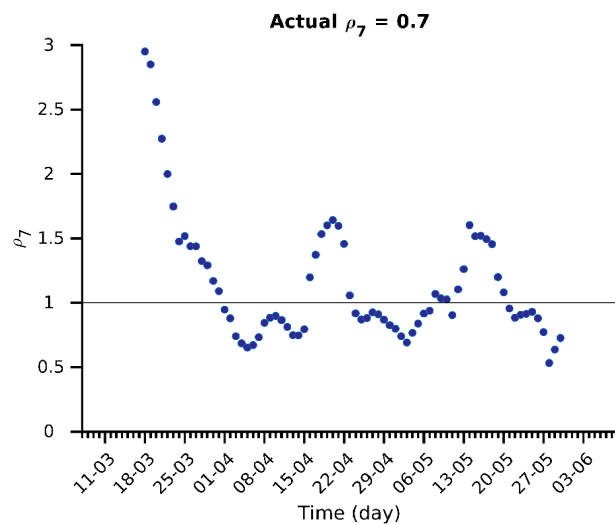
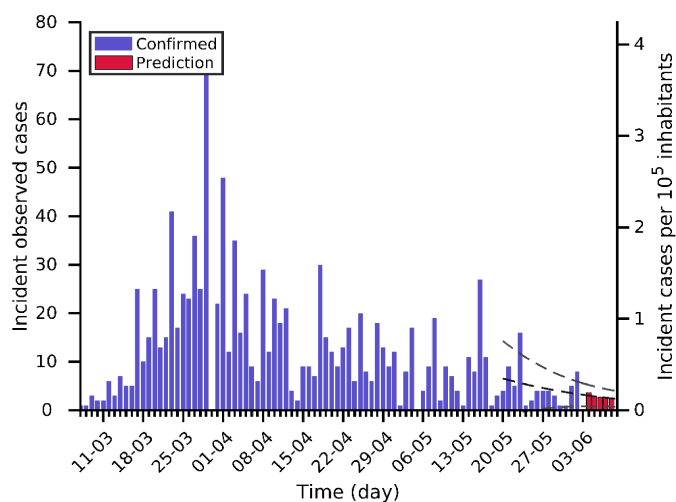
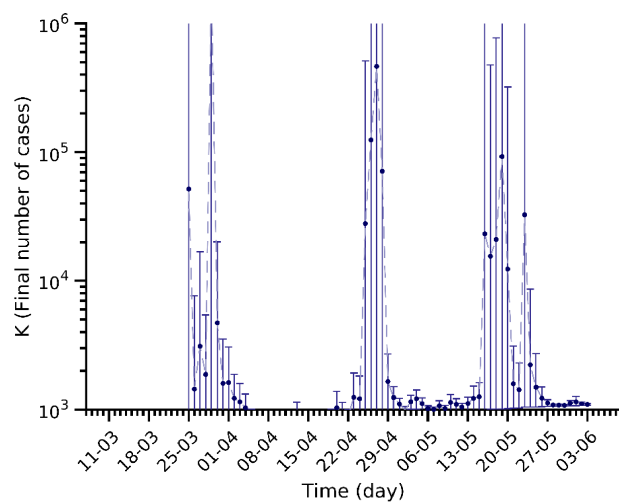
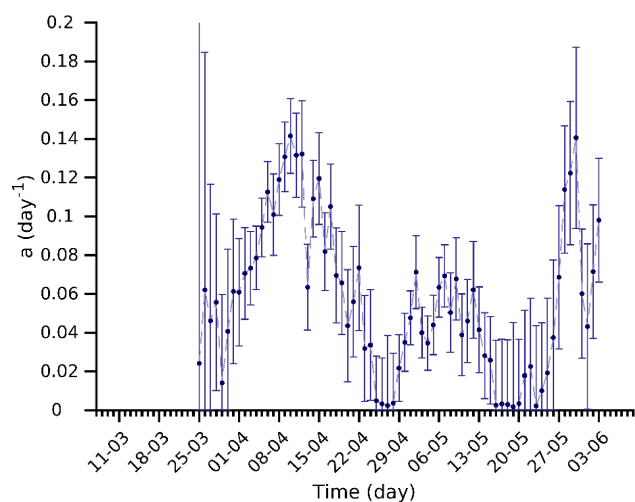
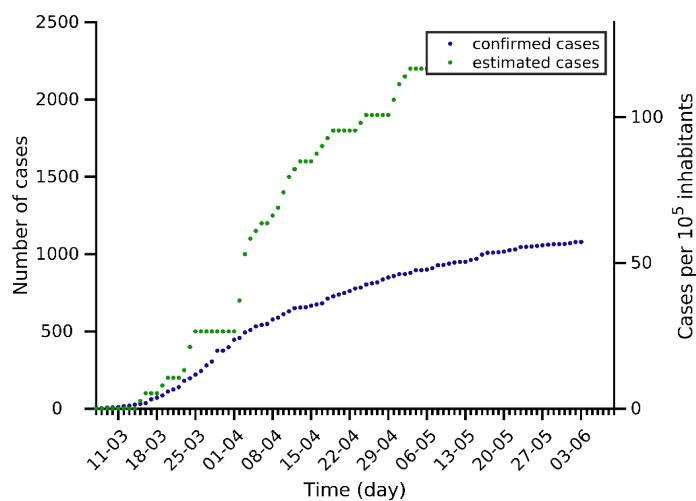
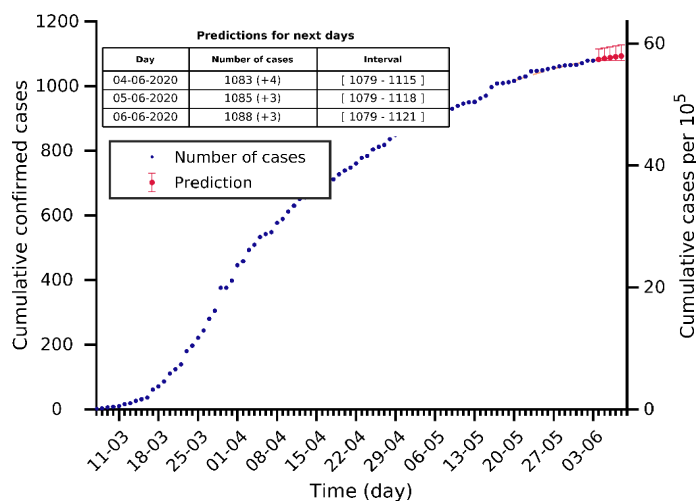
# Slovakia 03-06-2020. Population: 5.5M. Current cumulated incidence: $28/10^5$



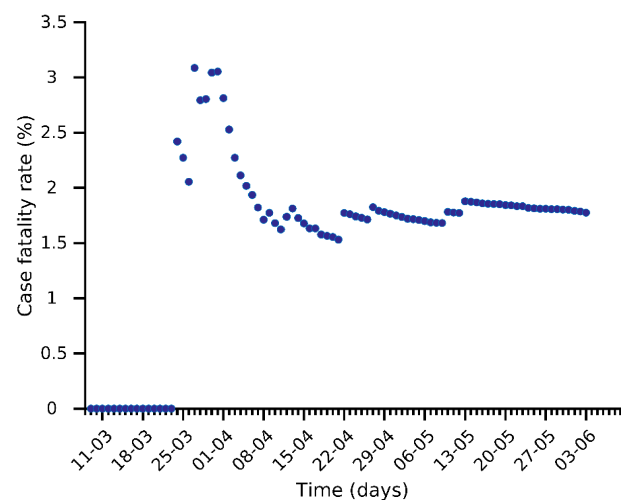
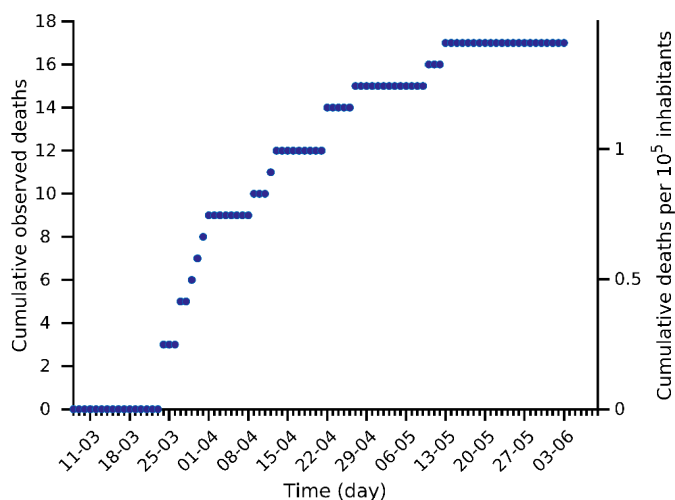
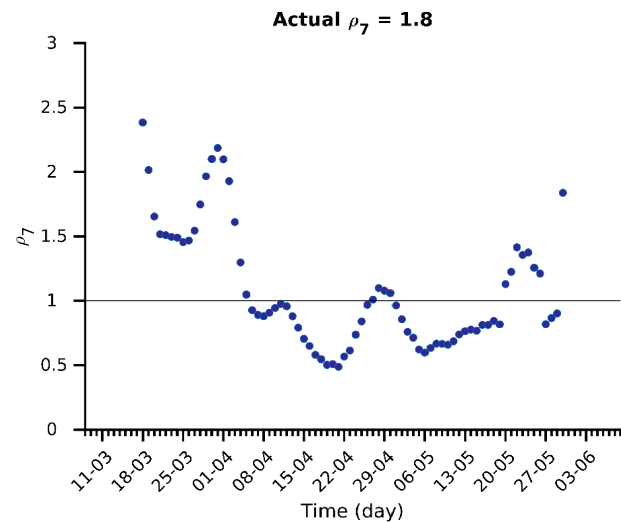
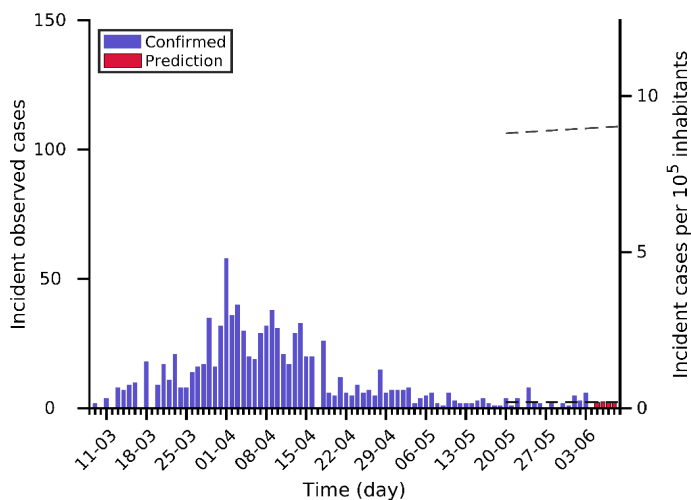
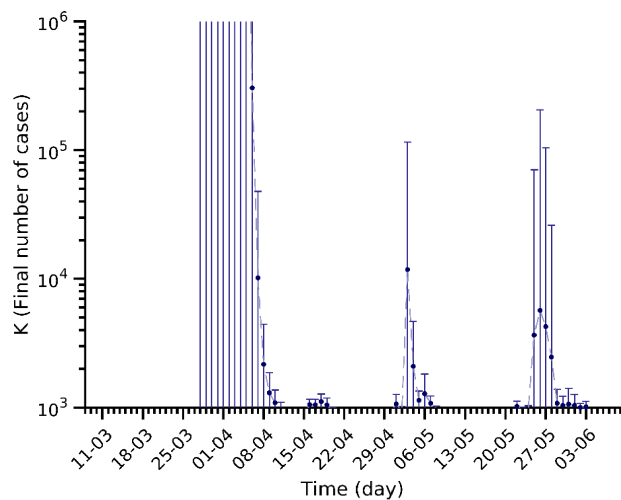
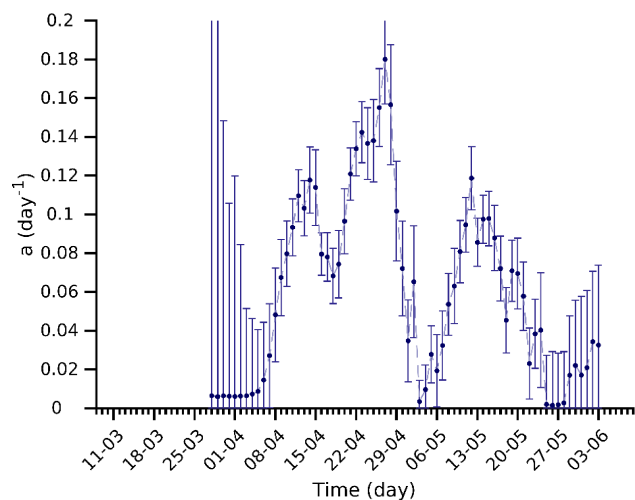
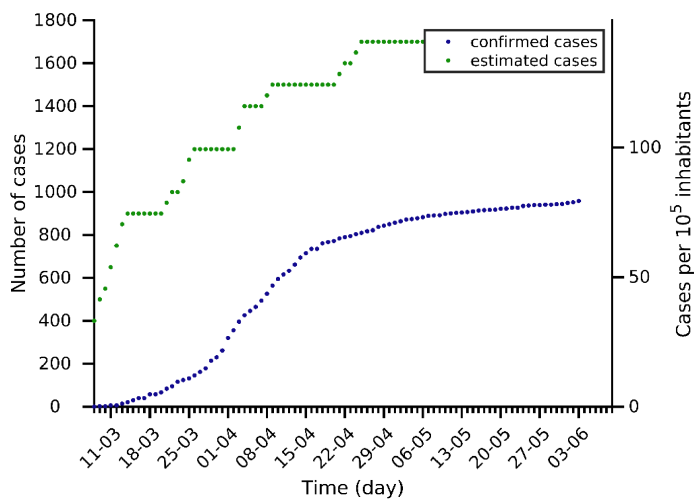
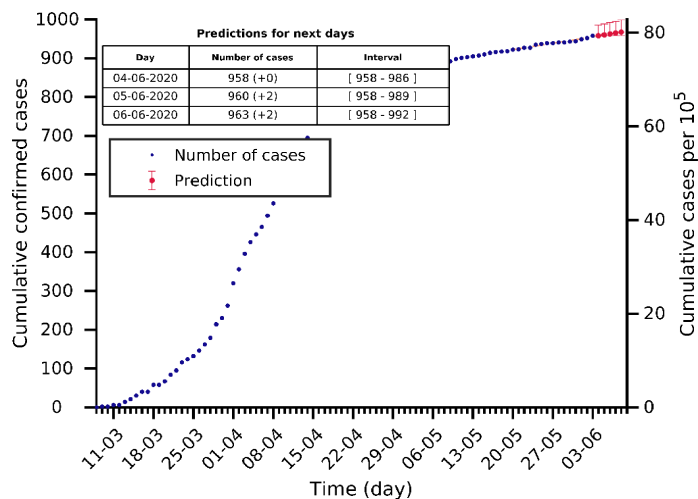
# Slovenia 03-06-2020. Population: 2.1M. Current cumulated incidence: 71/10<sup>5</sup>

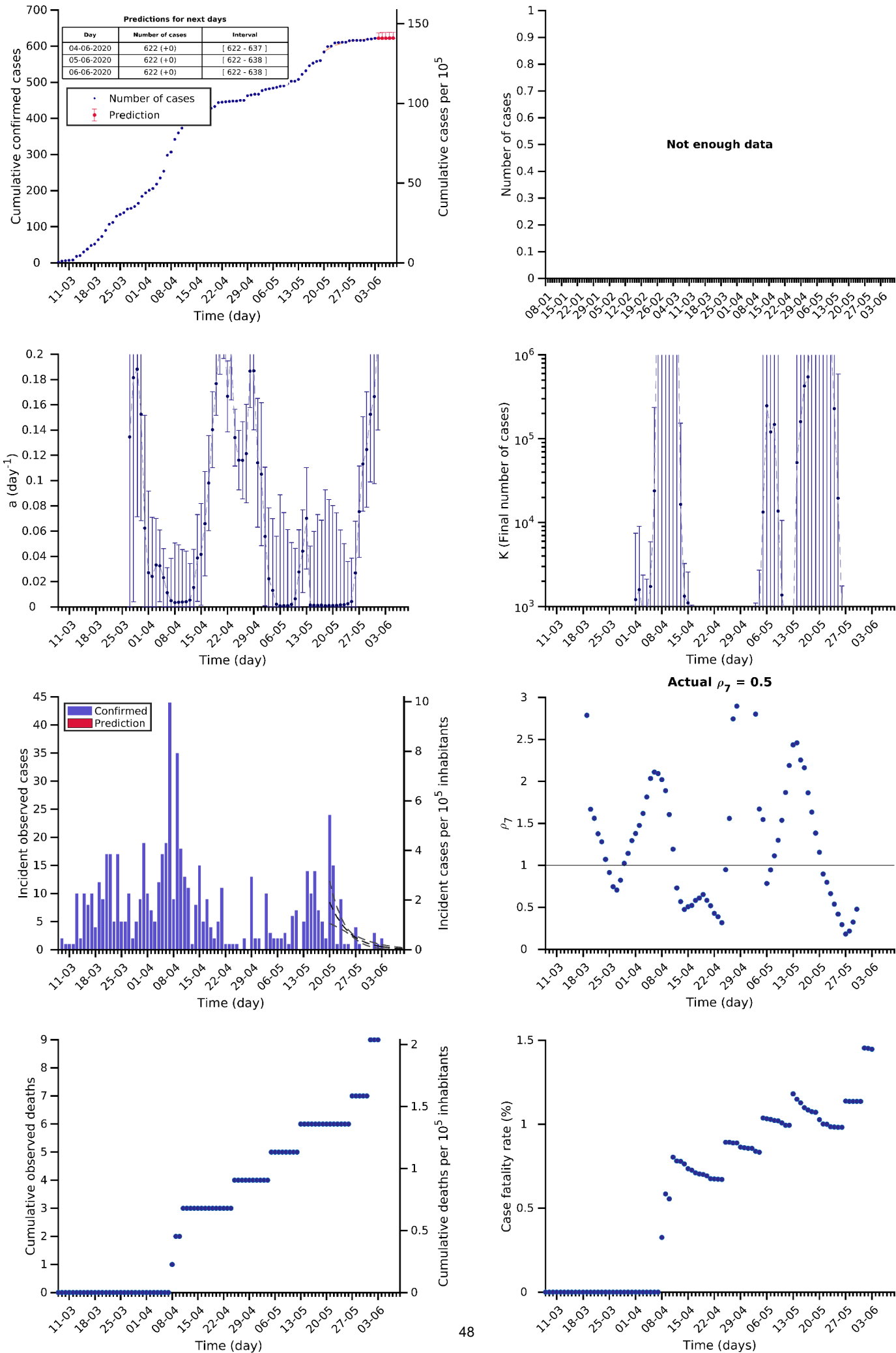


# Latvia 03-06-2020. Population: 1.9M. Current cumulated incidence: 57/10<sup>5</sup>



# Cyprus 03-06-2020. Population: 1.2M. Current cumulated incidence: 79/10<sup>5</sup>



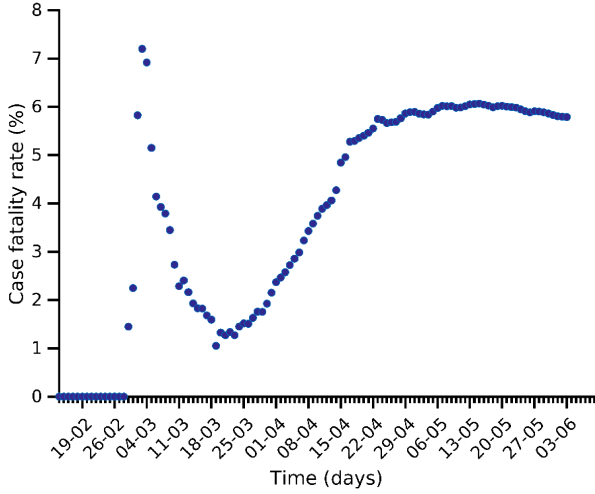
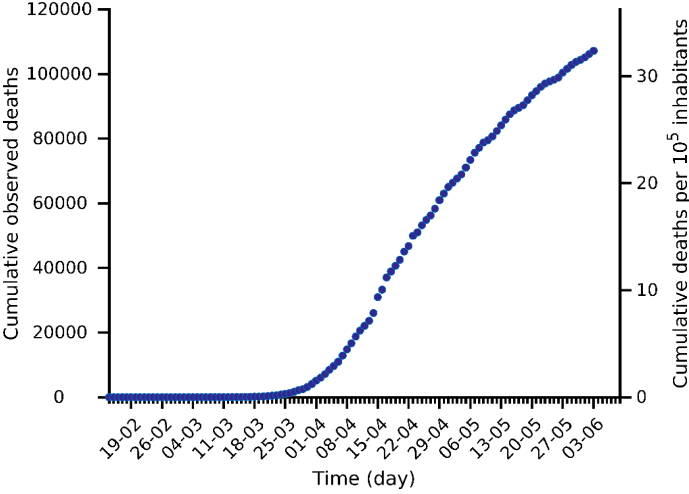
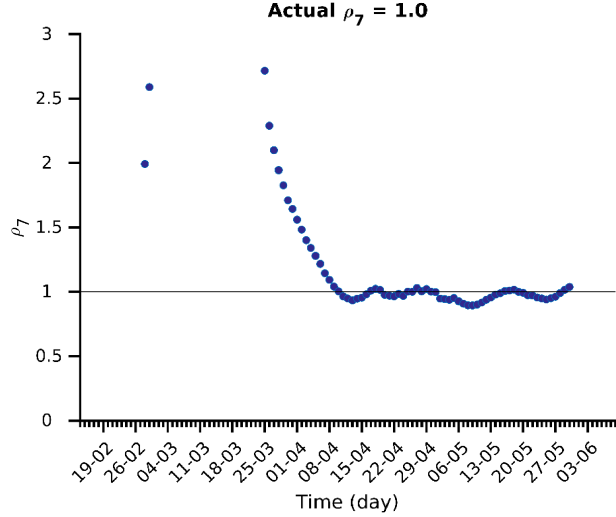
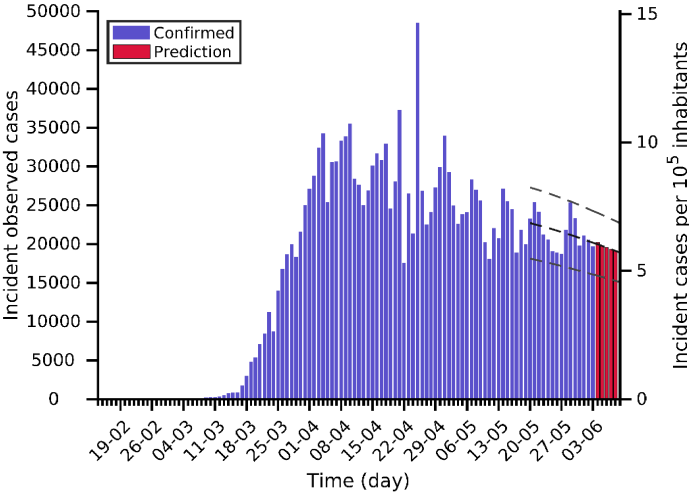
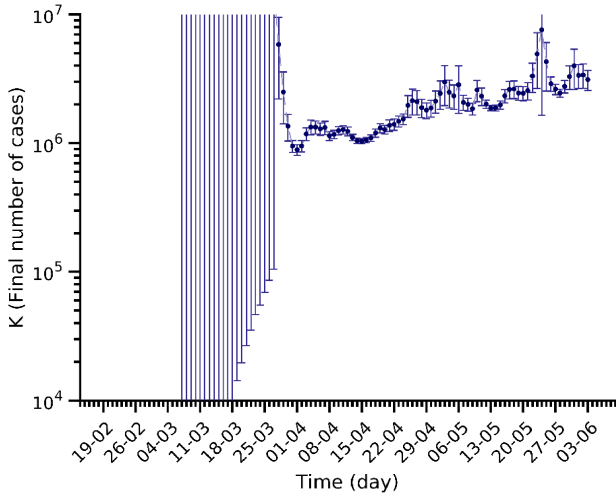
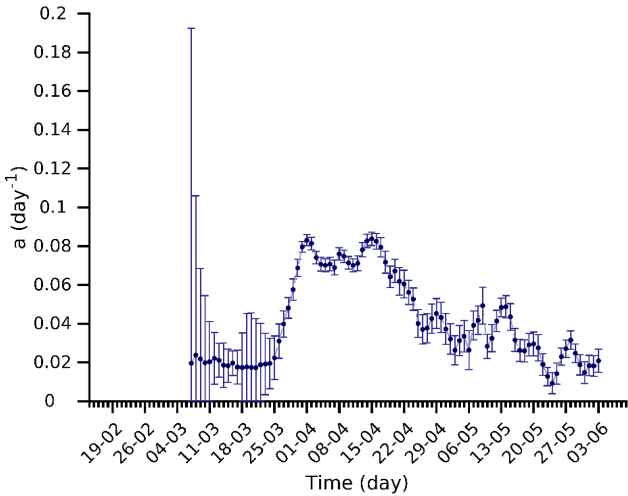
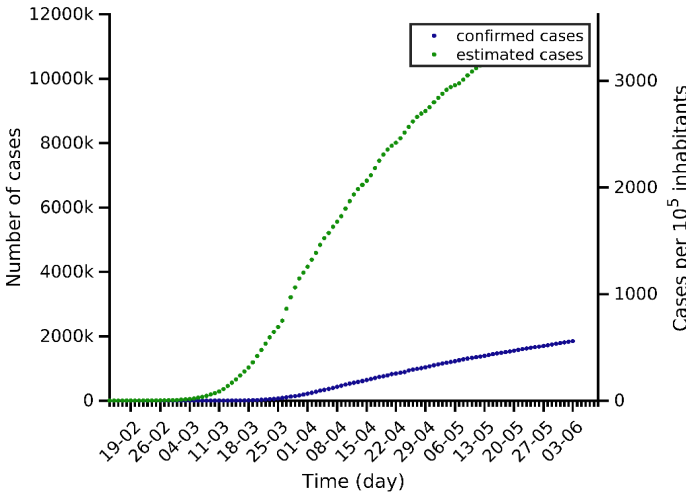
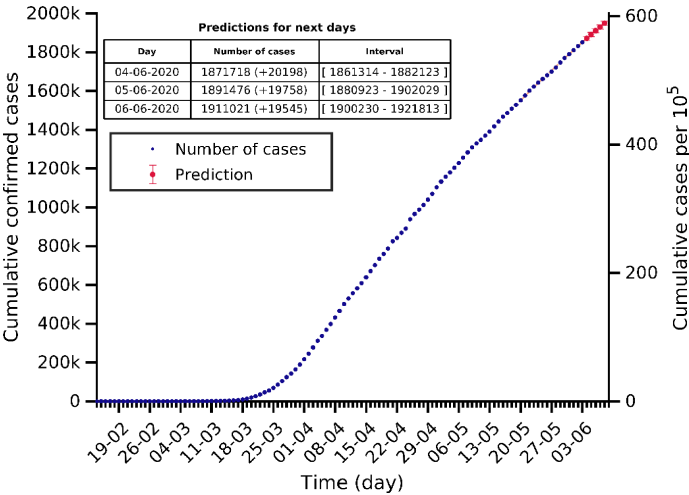


## **(2) Analysis and prediction of COVID-19 for other countries**

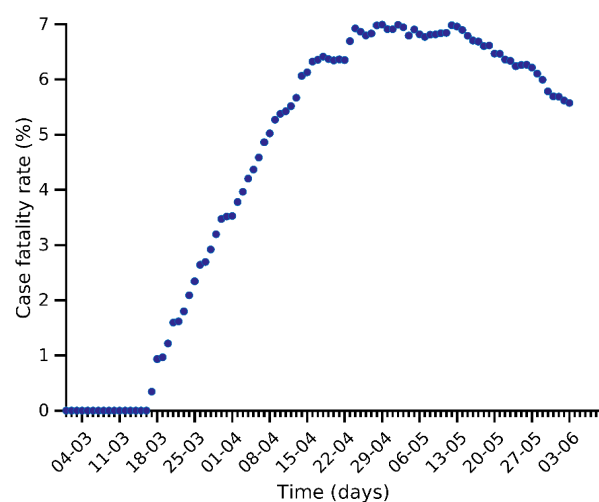
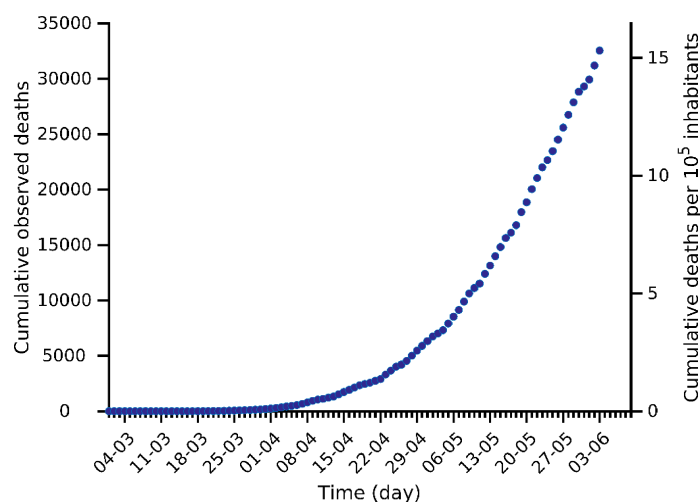
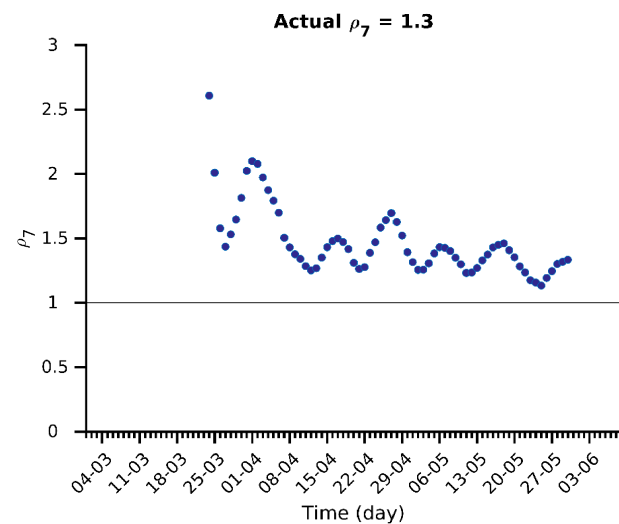
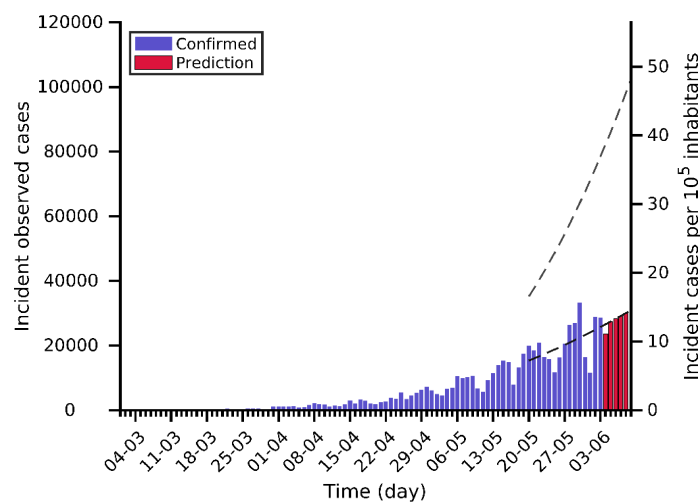
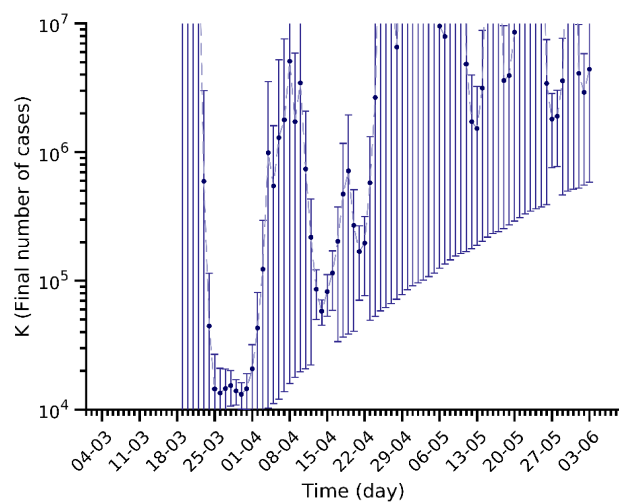
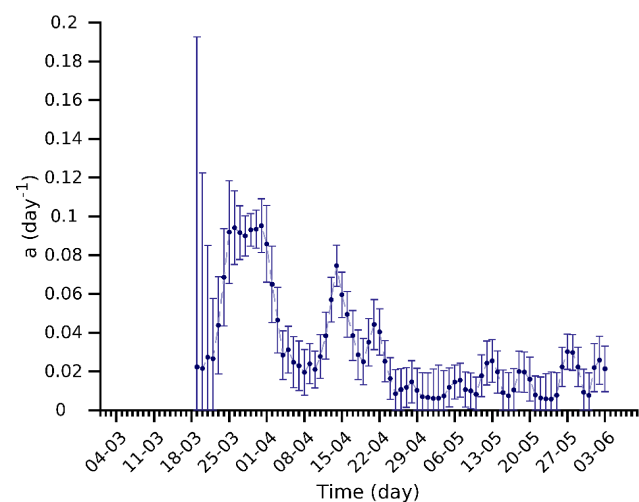
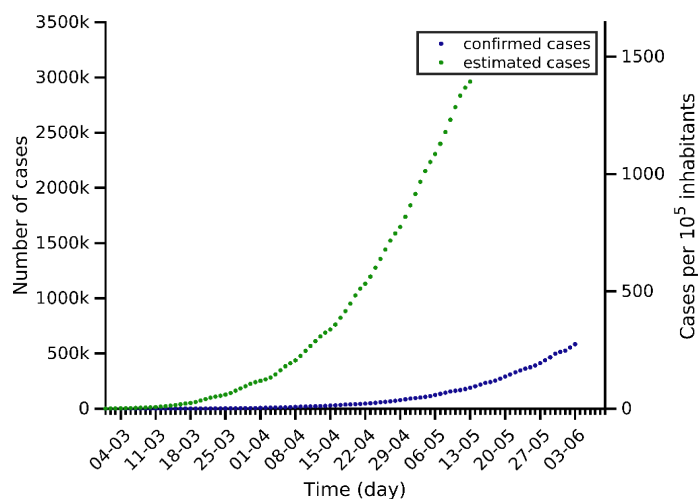
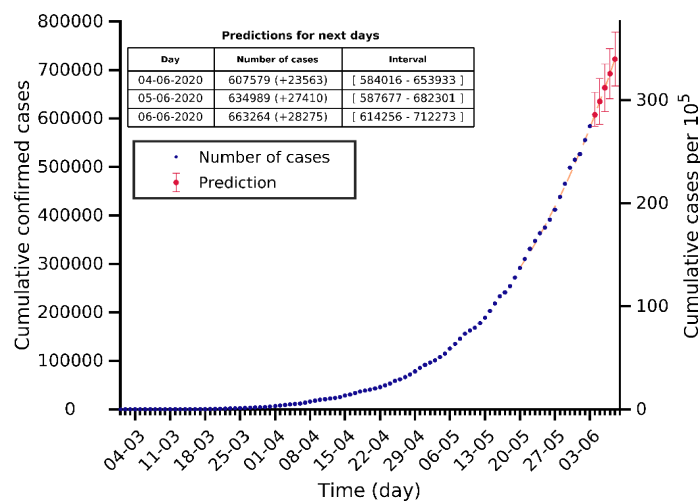
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



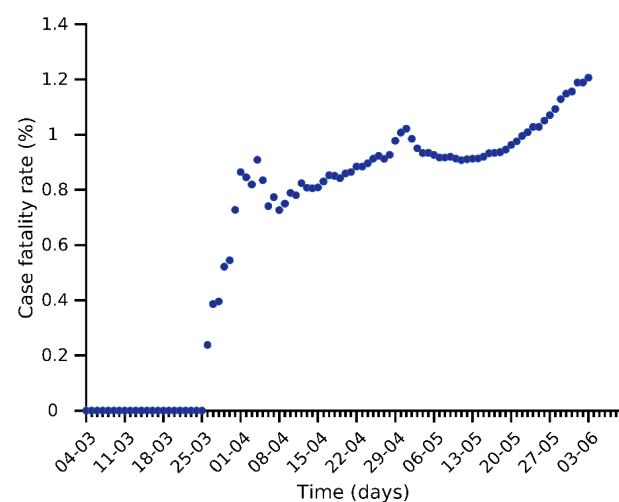
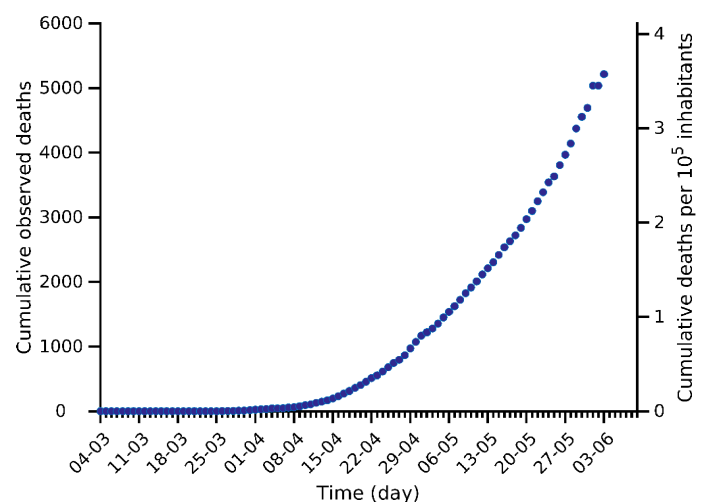
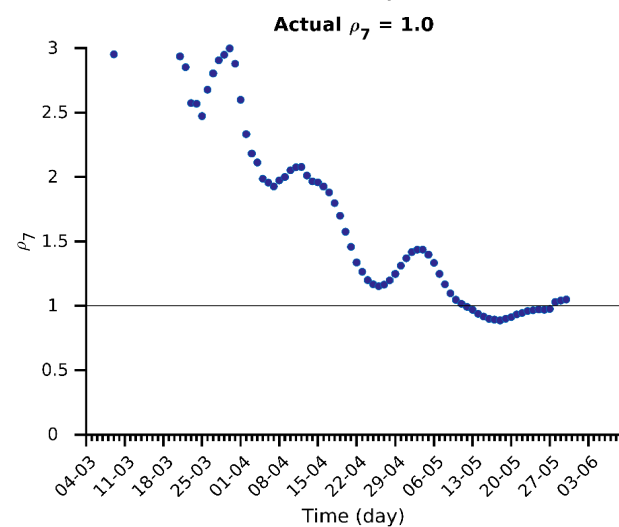
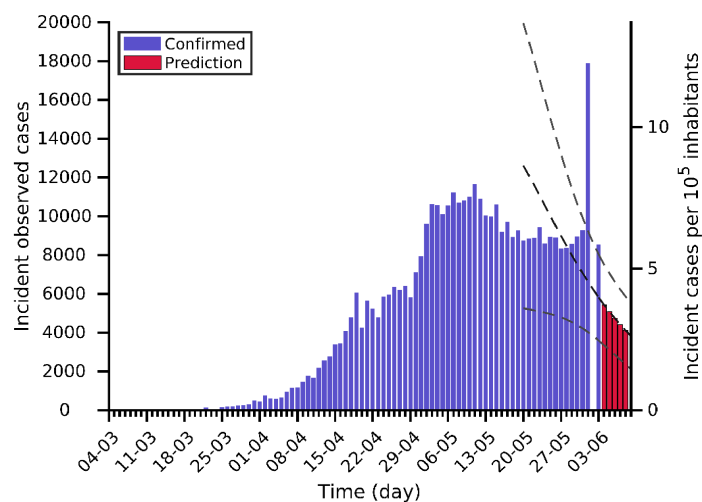
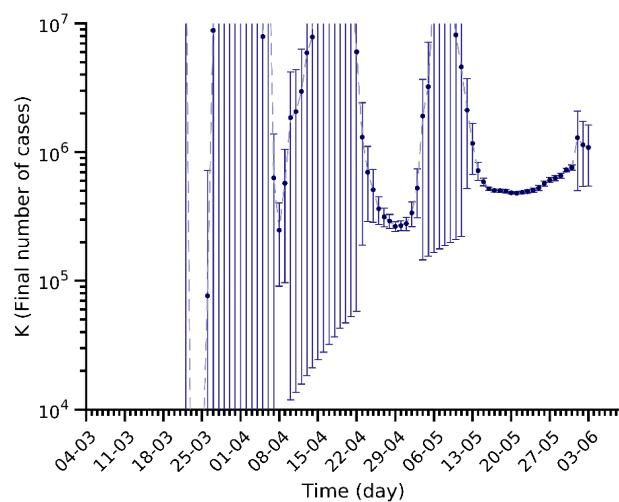
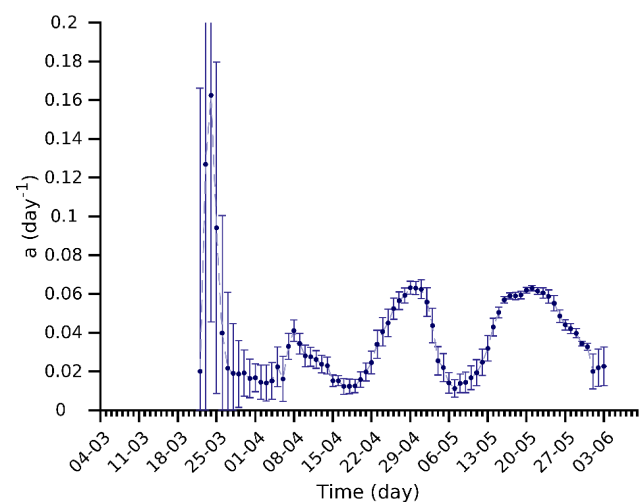
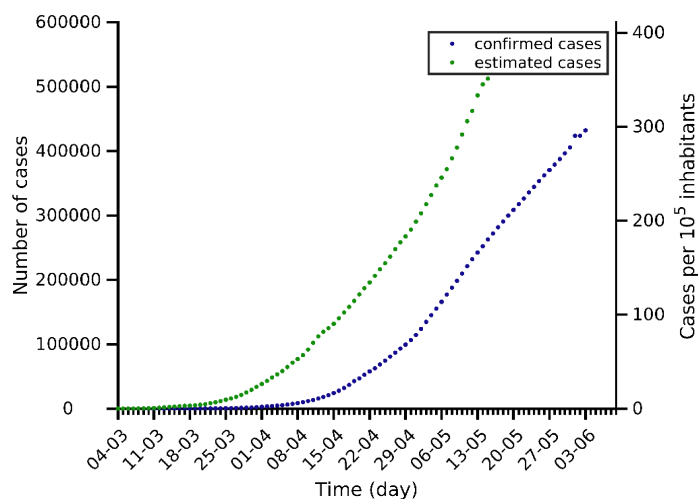
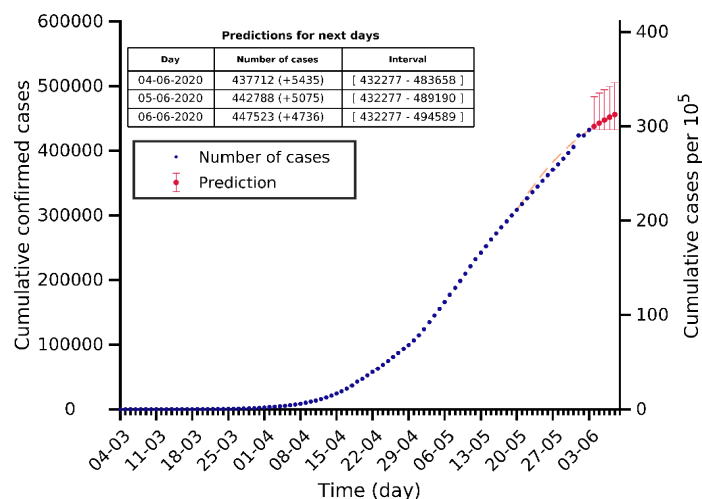
USA 03-06-2020. Population: 331.0M. Current cumulated incidence: 559/10<sup>5</sup>



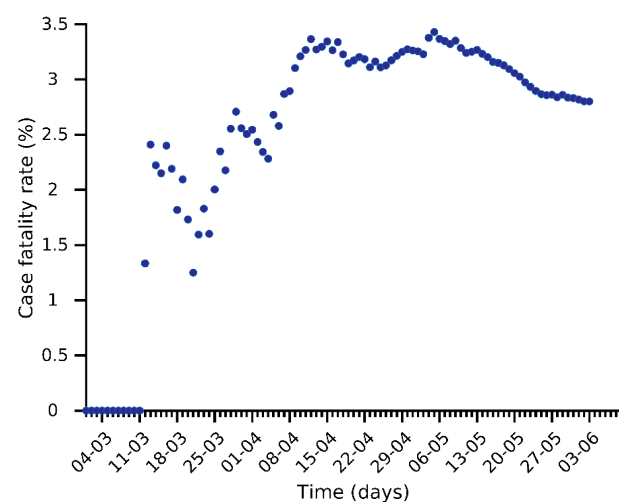
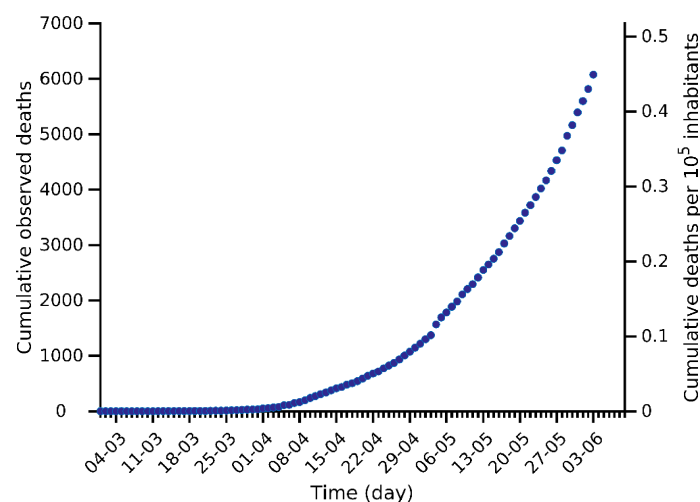
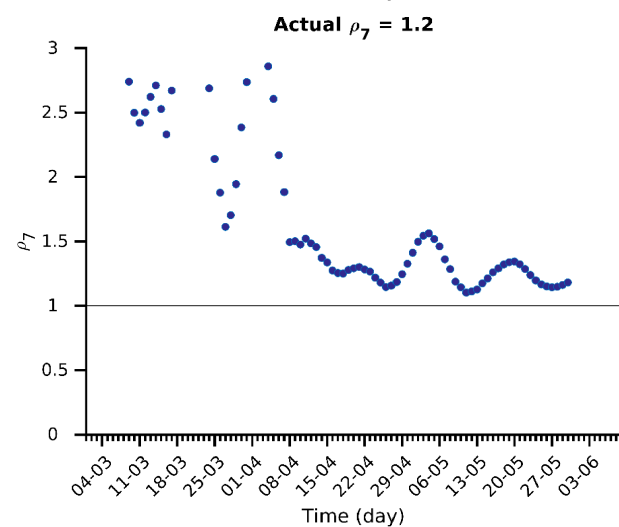
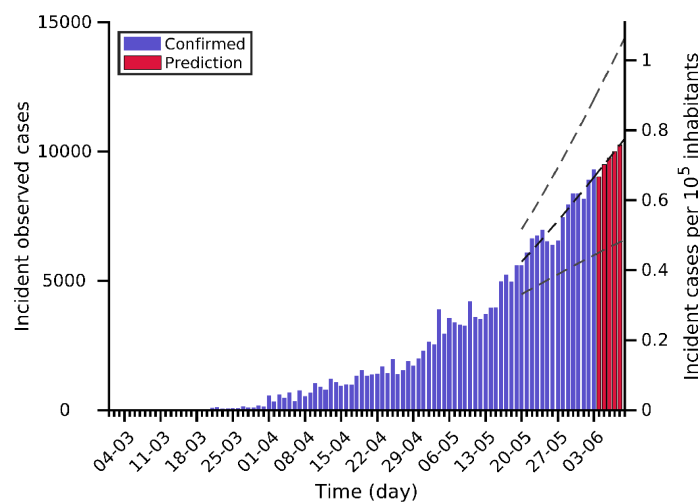
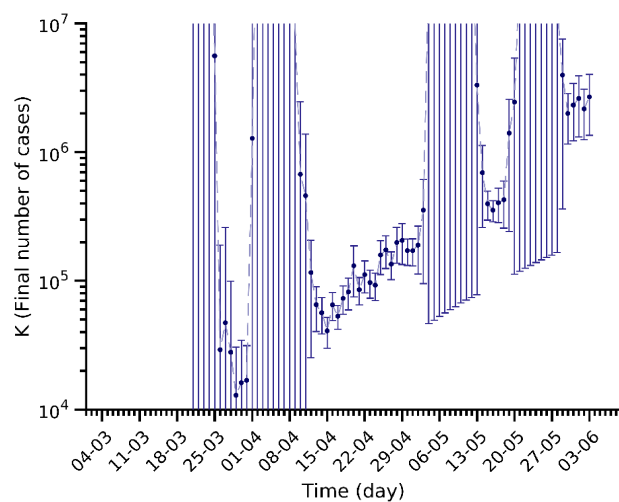
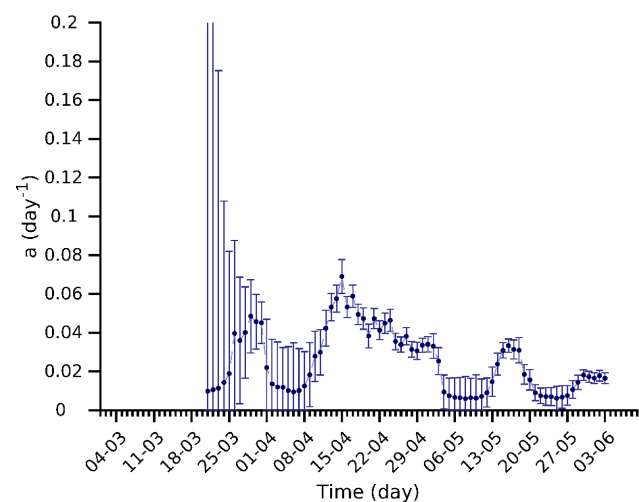
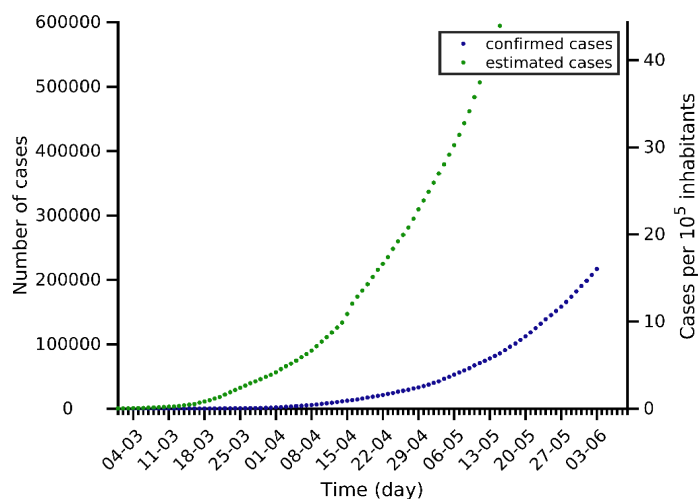
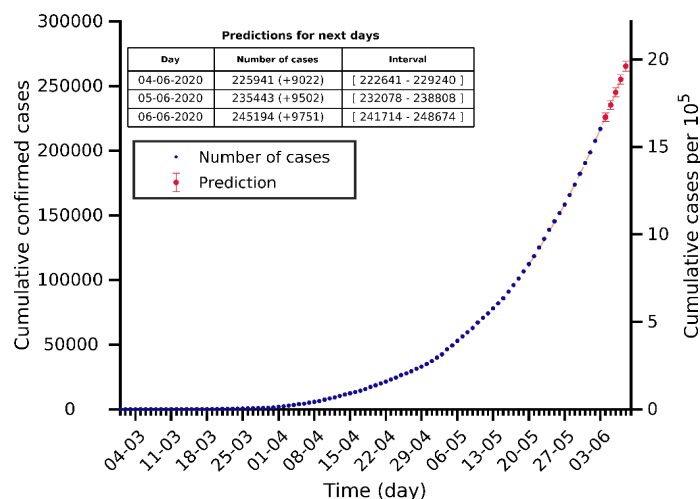
# Brazil 03-06-2020. Population: 212.6M. Current cumulated incidence: 275/10<sup>5</sup>



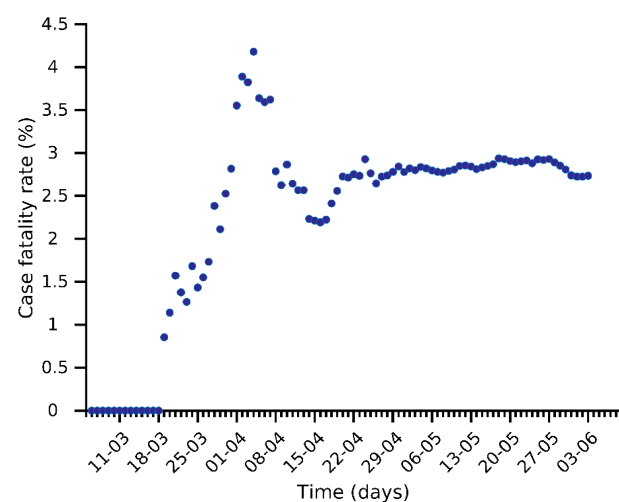
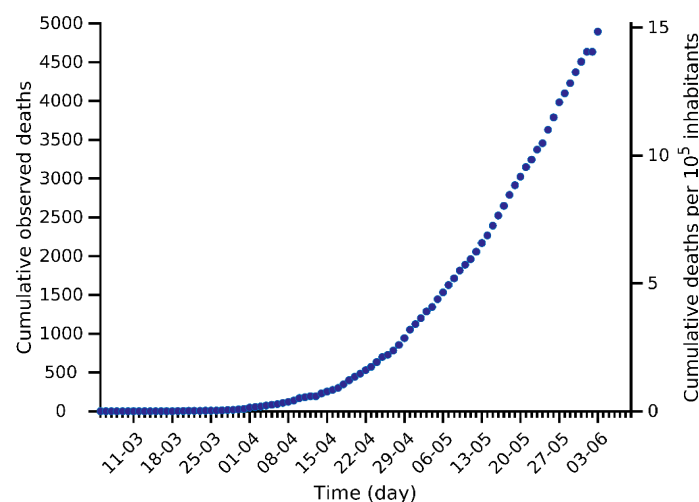
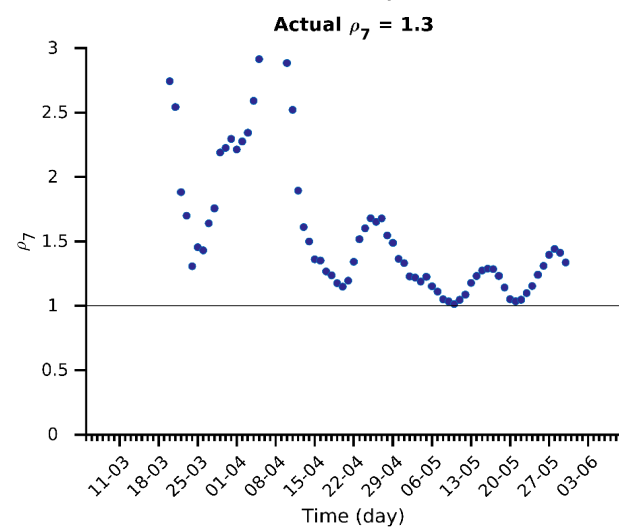
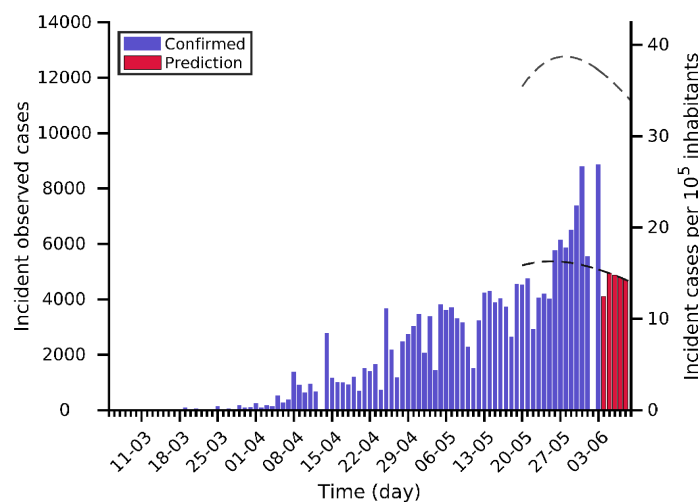
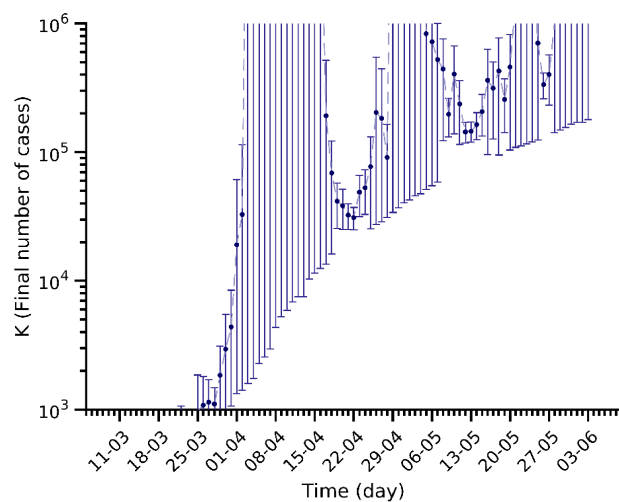
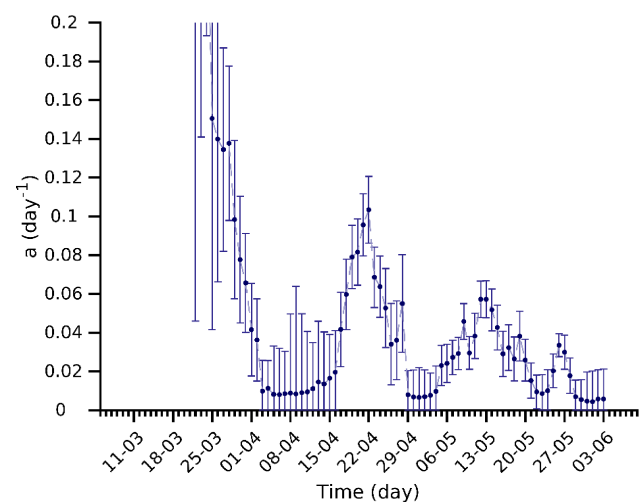
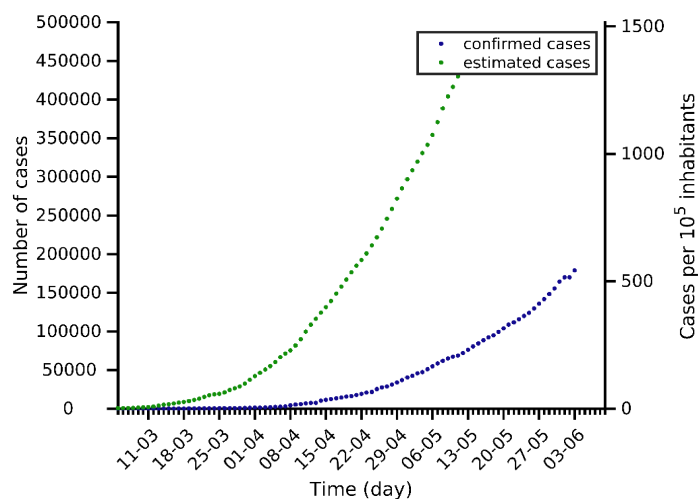
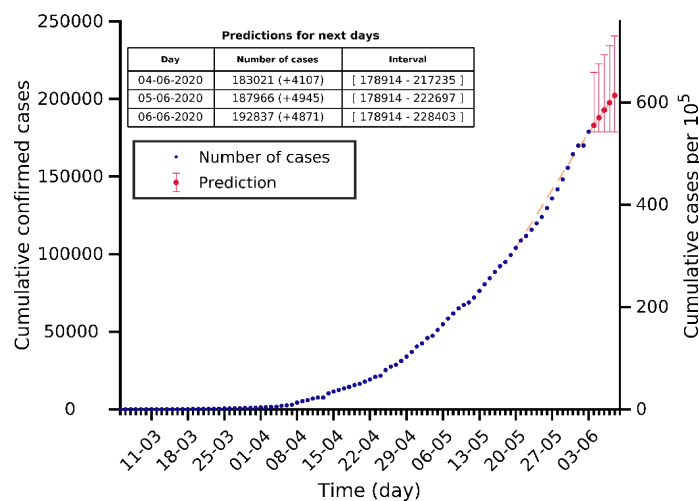
# Russia 03-06-2020. Population: 145.9M. Current cumulated incidence: 296/10<sup>5</sup>



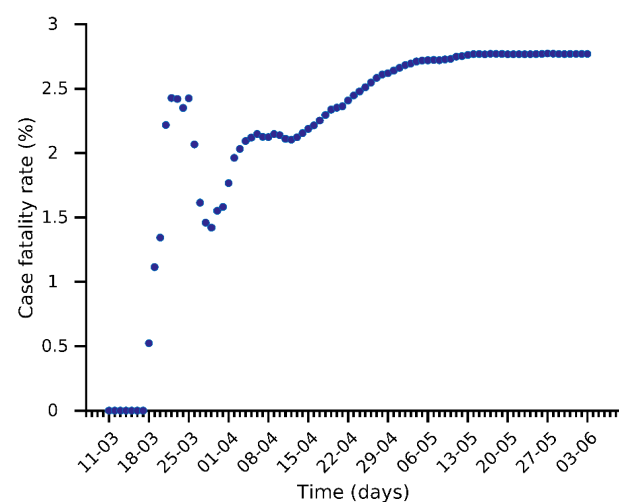
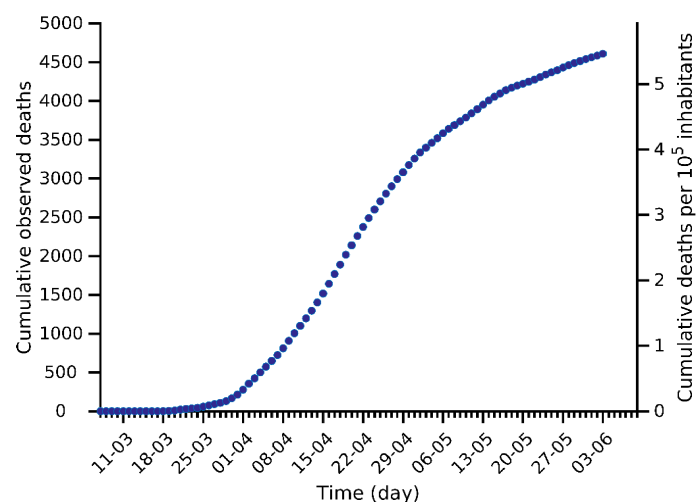
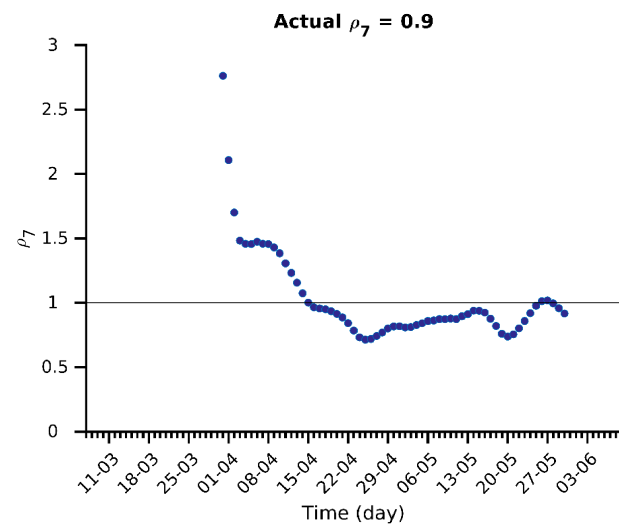
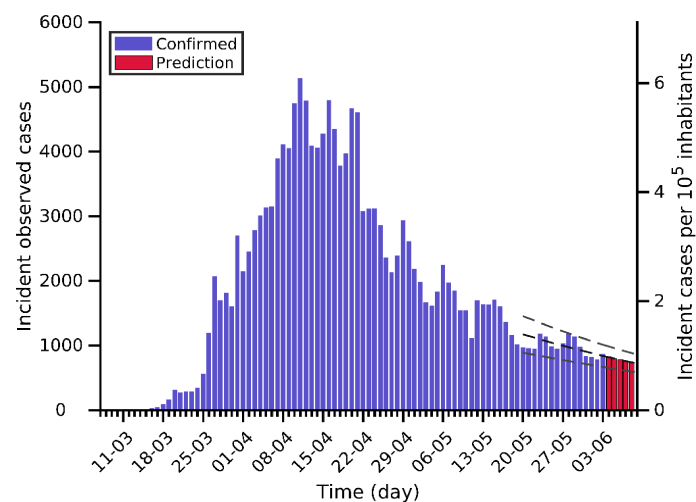
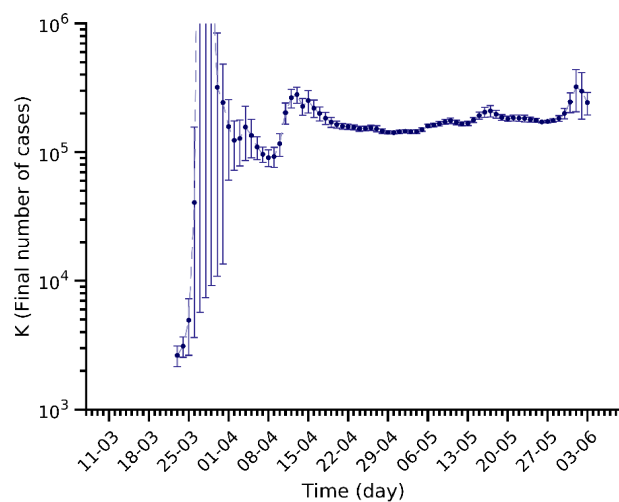
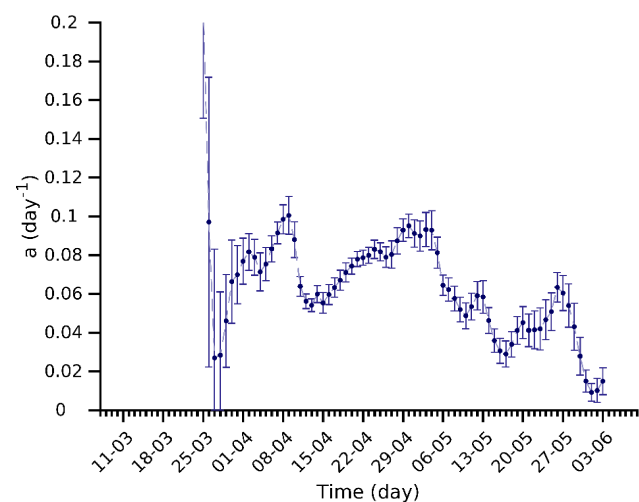
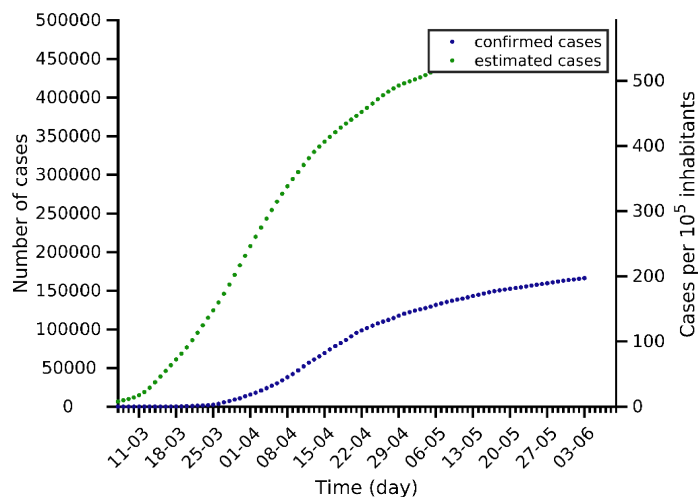
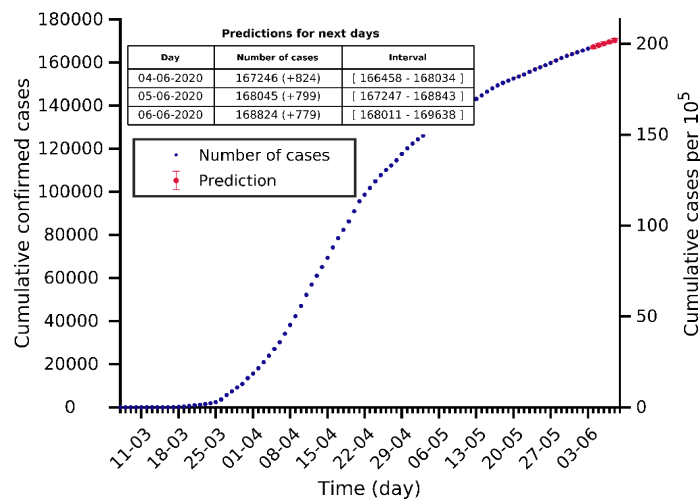
# India 03-06-2020. Population: 1353.0M. Current cumulated incidence: 16/10<sup>5</sup>



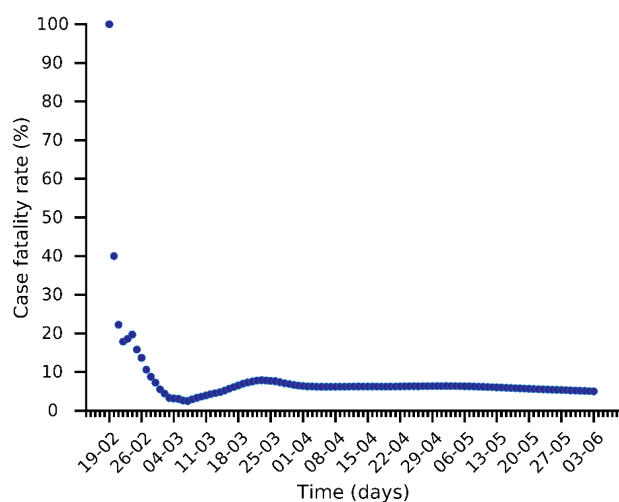
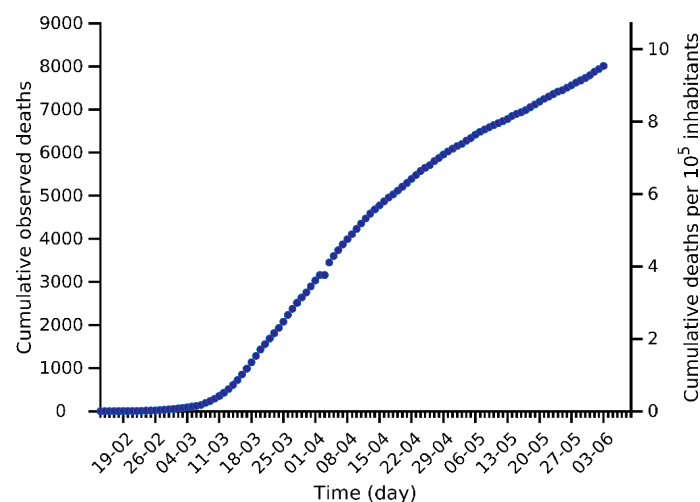
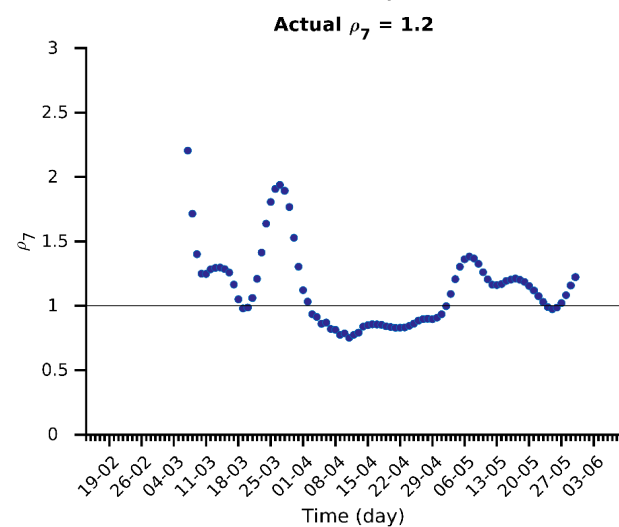
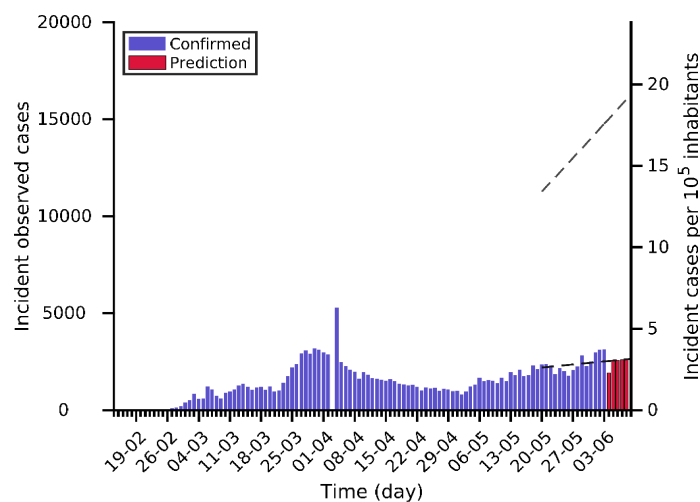
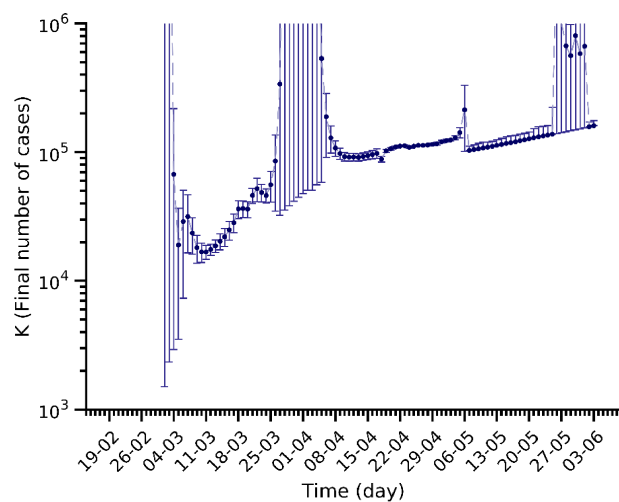
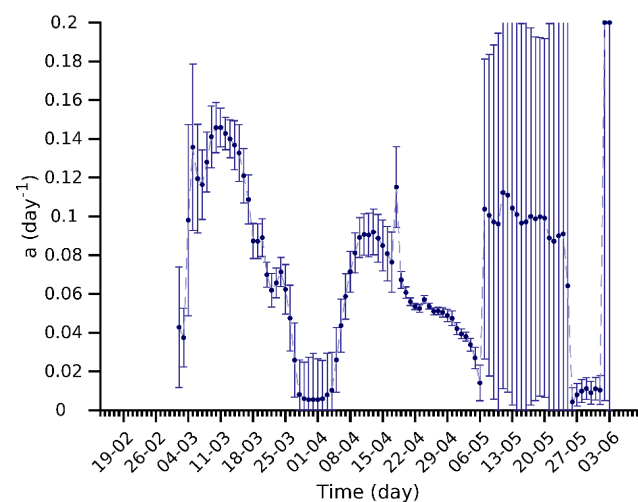
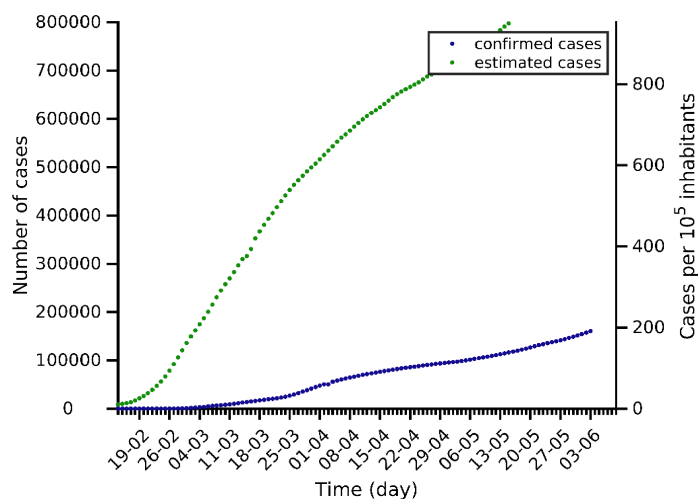
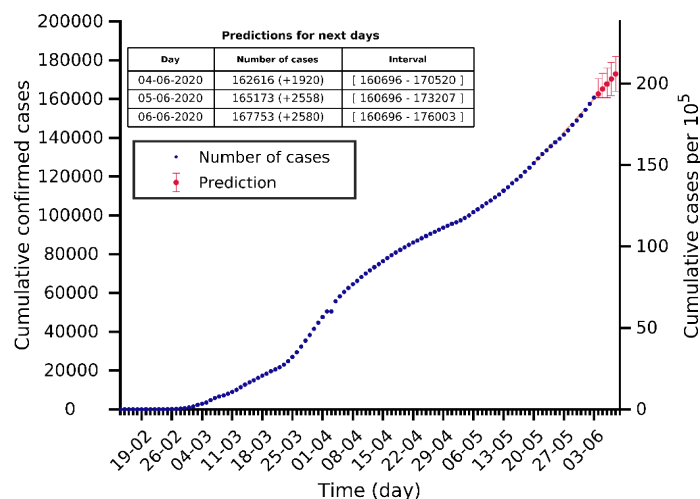
# Peru 03-06-2020. Population: 33.0M. Current cumulated incidence: 543/10<sup>5</sup>



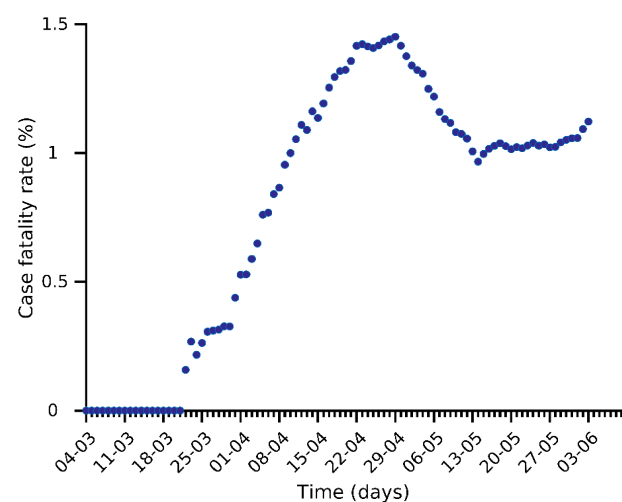
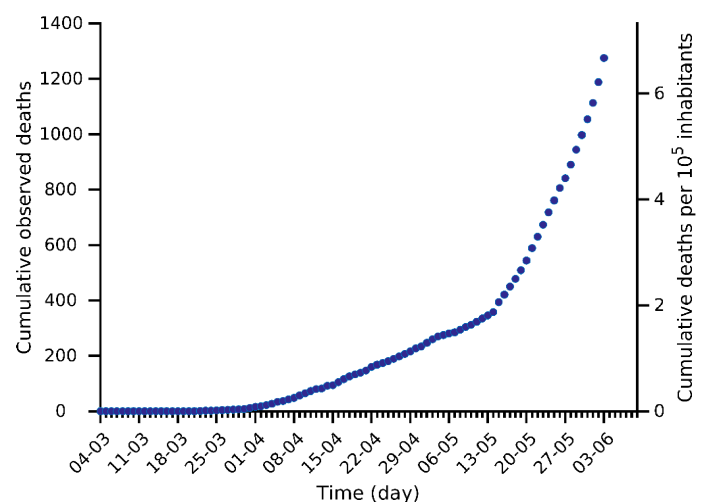
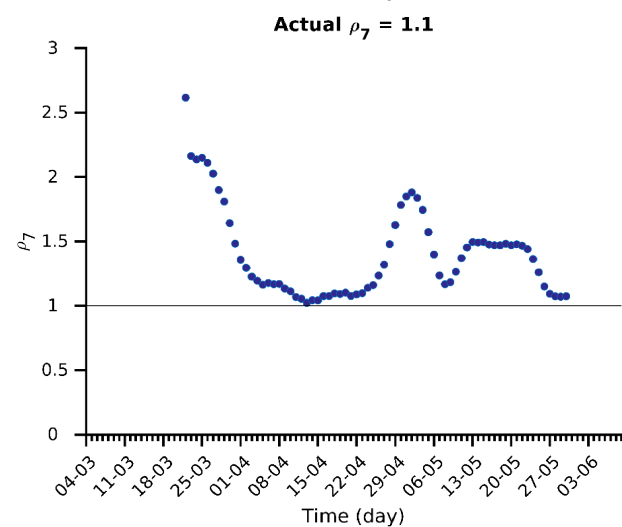
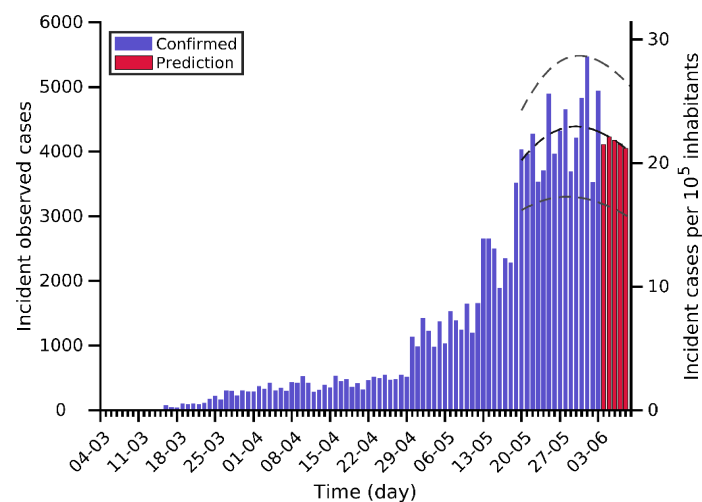
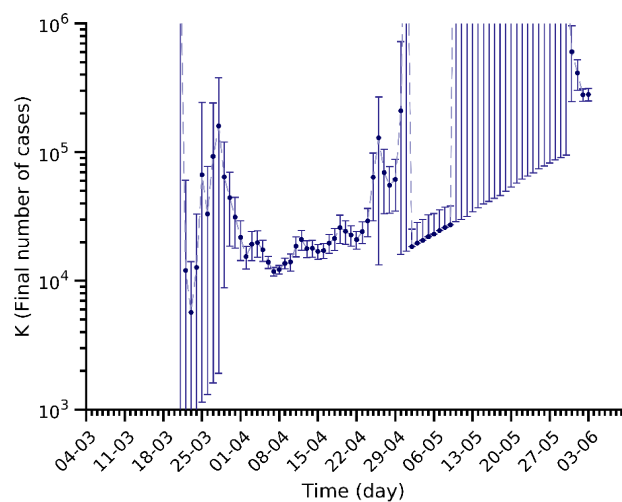
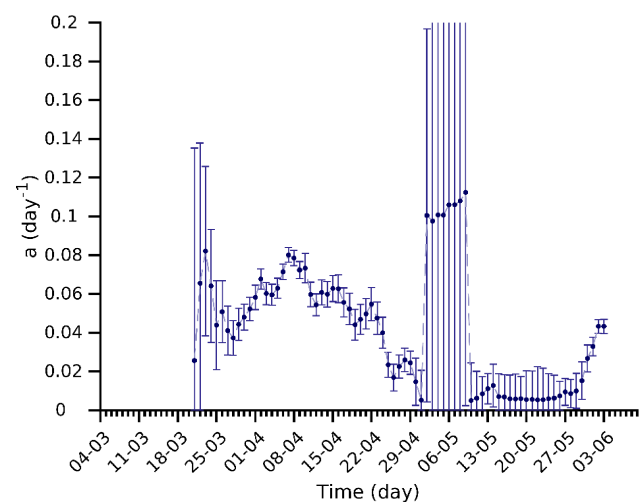
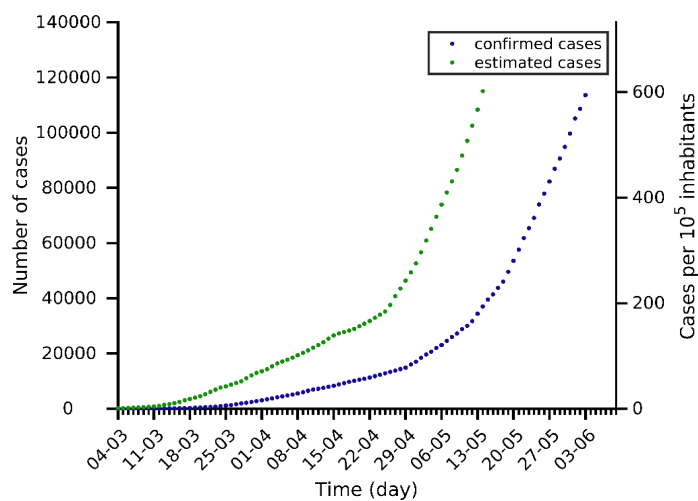
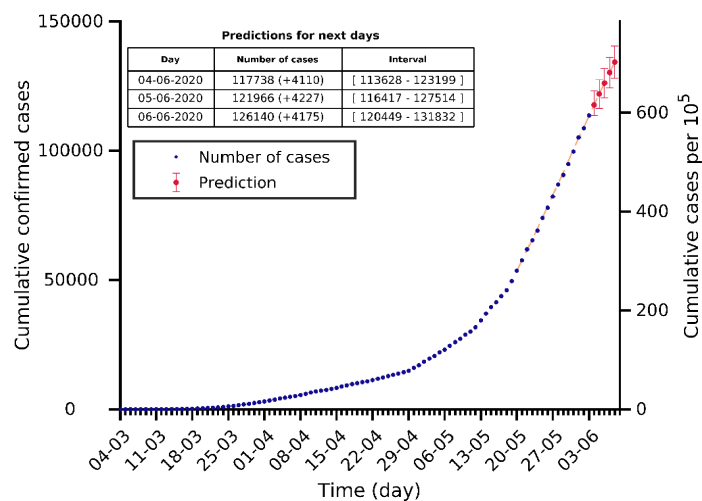
# Turkey 03-06-2020. Population: 84.3M. Current cumulated incidence: 197/10<sup>5</sup>



# Iran 03-06-2020. Population: 84.0M. Current cumulated incidence: 191/10<sup>5</sup>

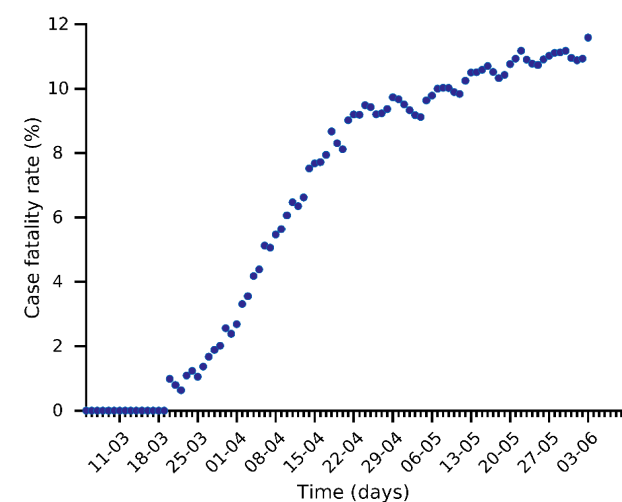
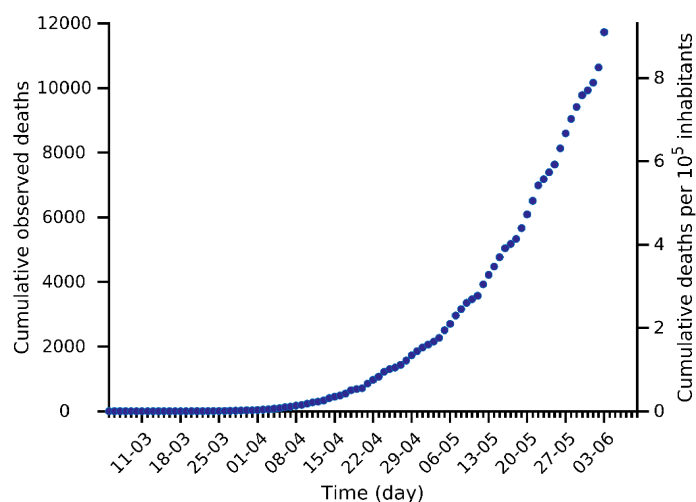
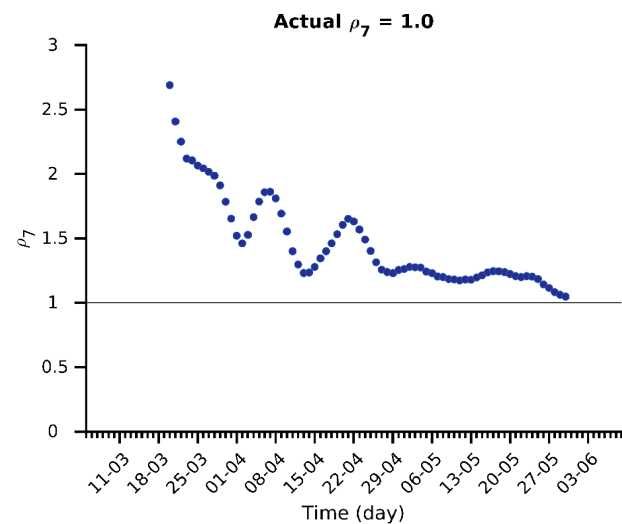
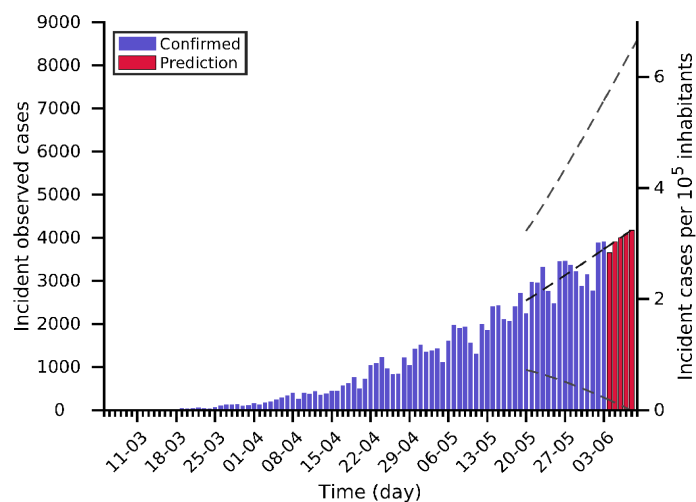
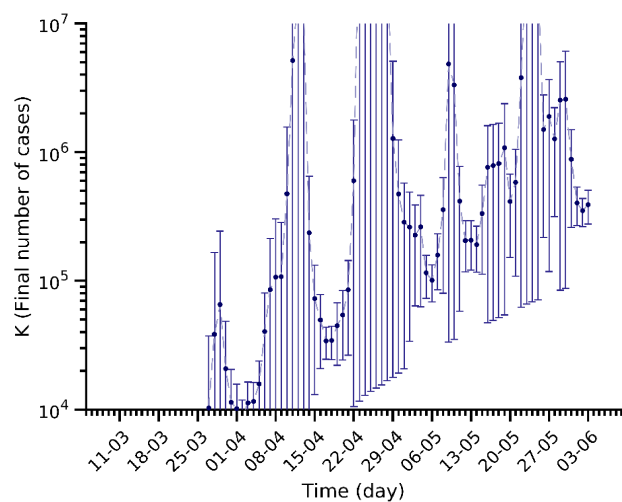
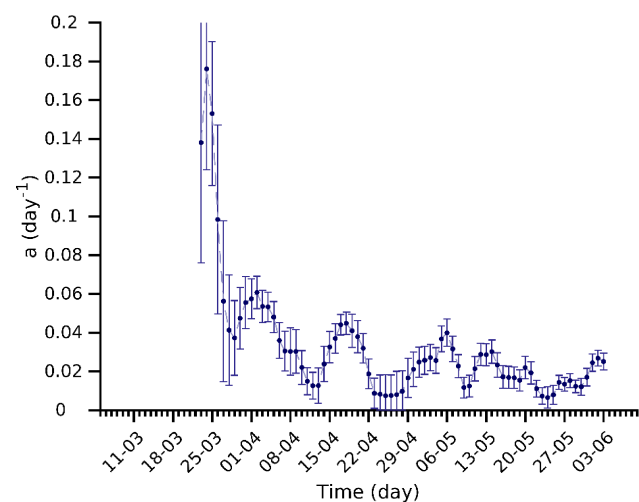
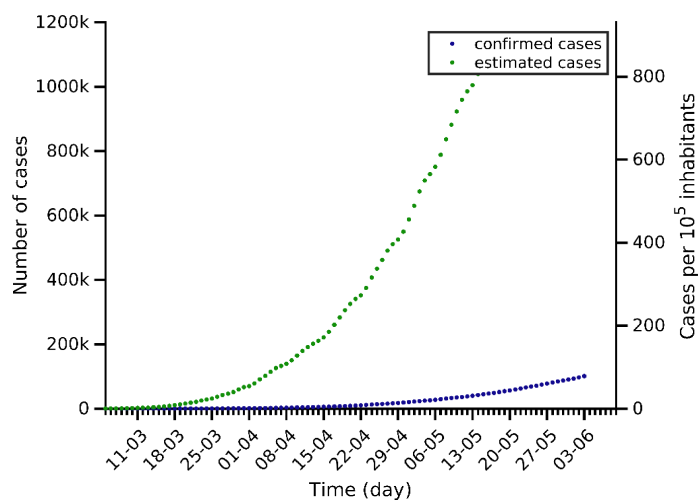
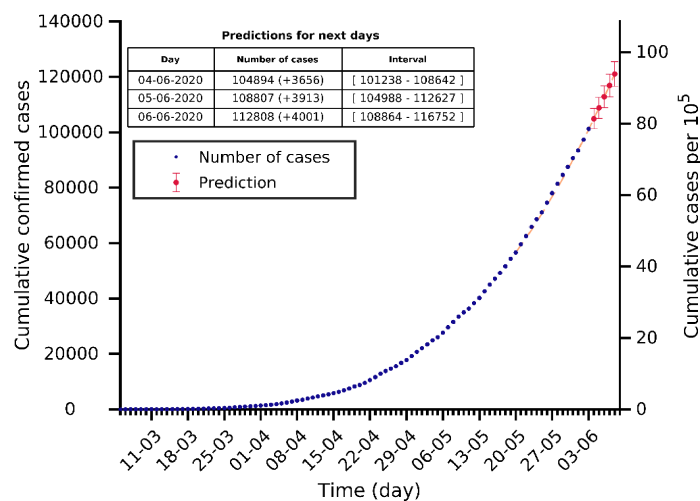


# Chile 03-06-2020. Population: 19.1M. Current cumulated incidence: 594/10<sup>5</sup>

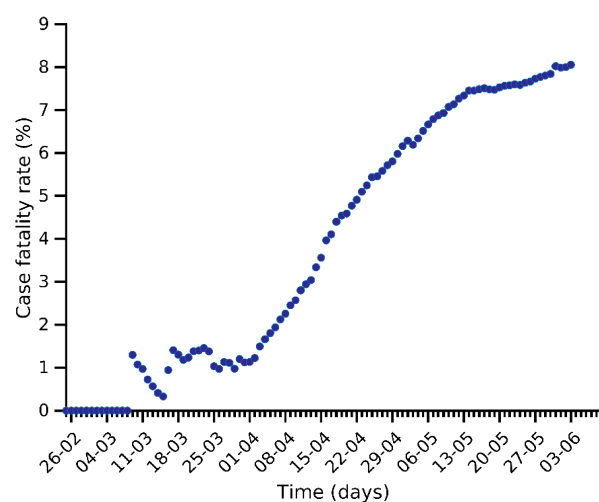
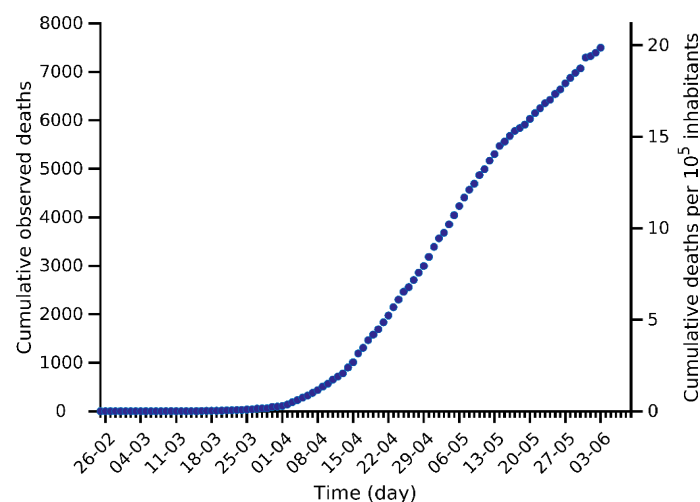
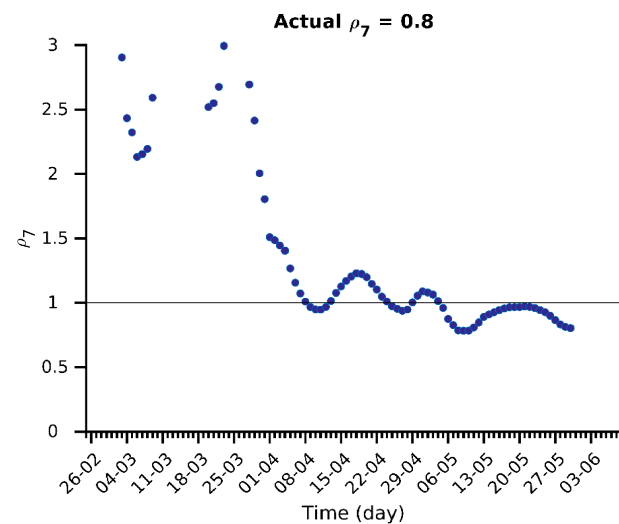
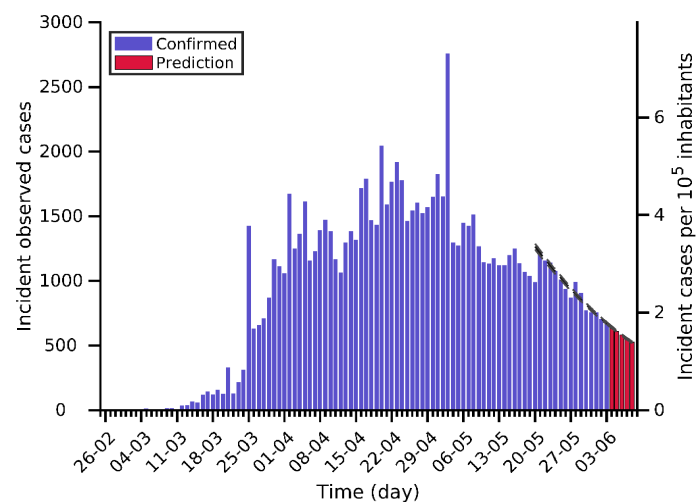
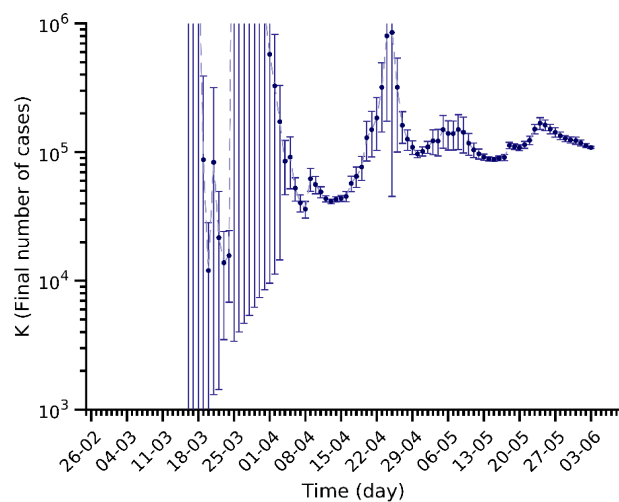
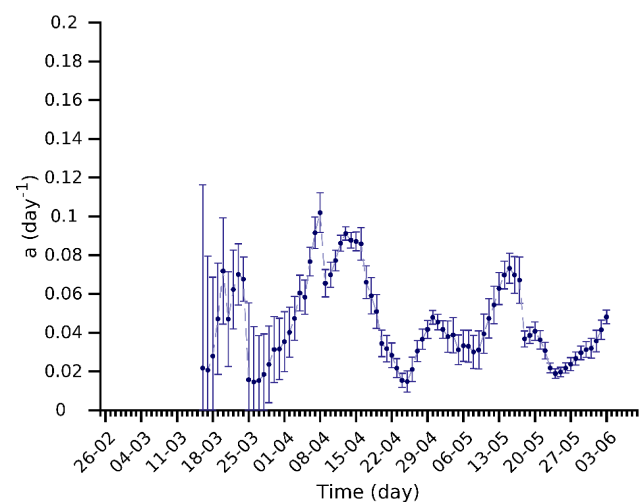
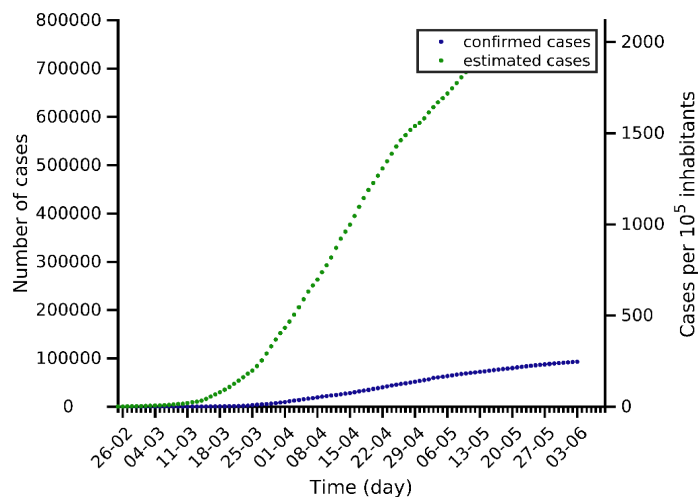
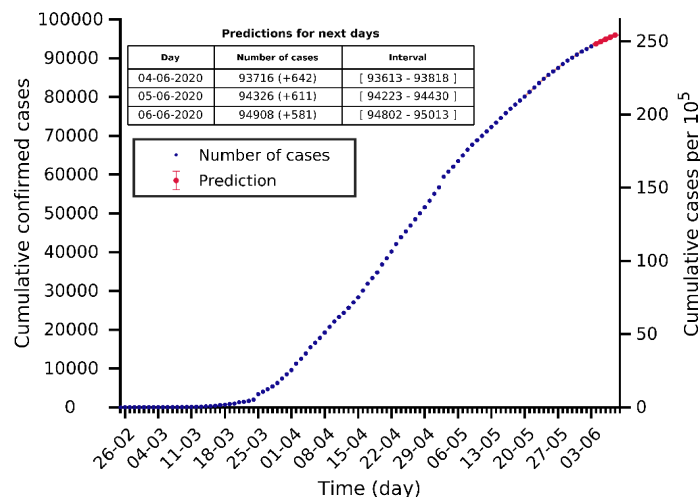


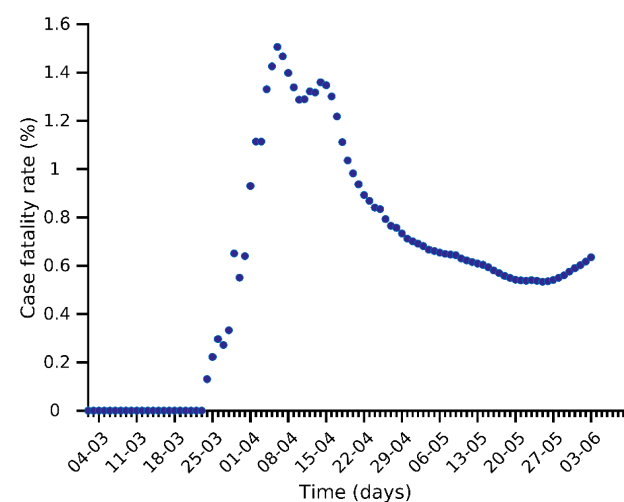
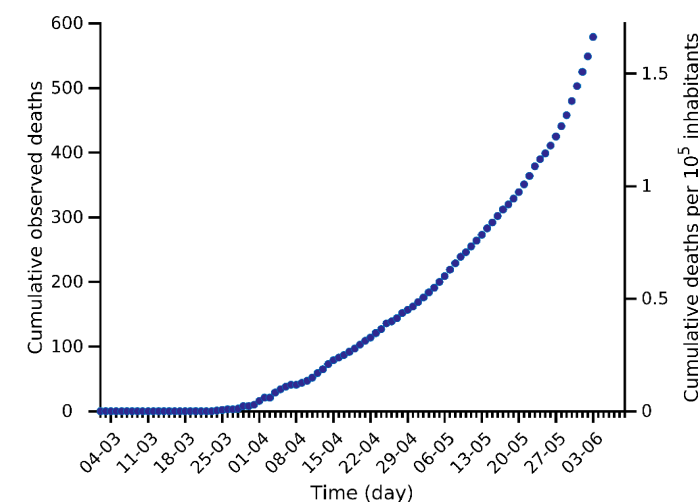
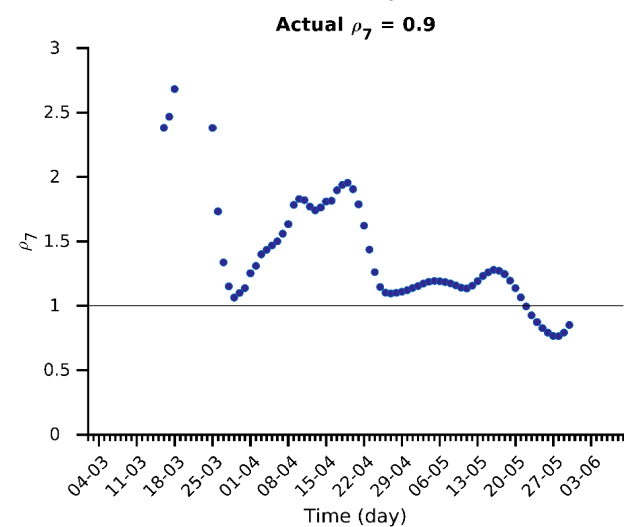
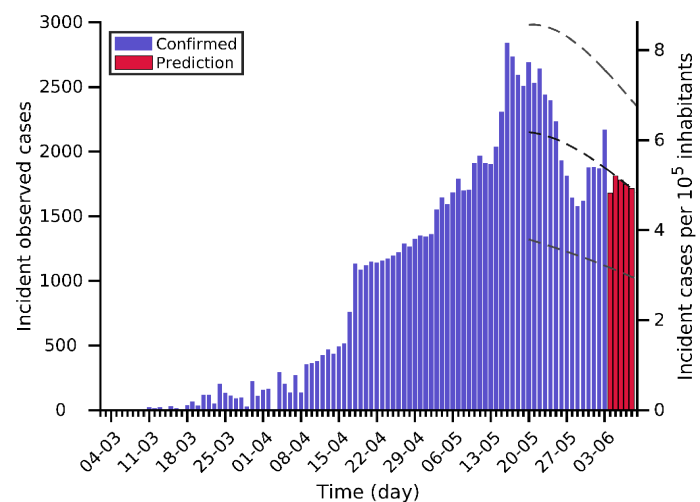
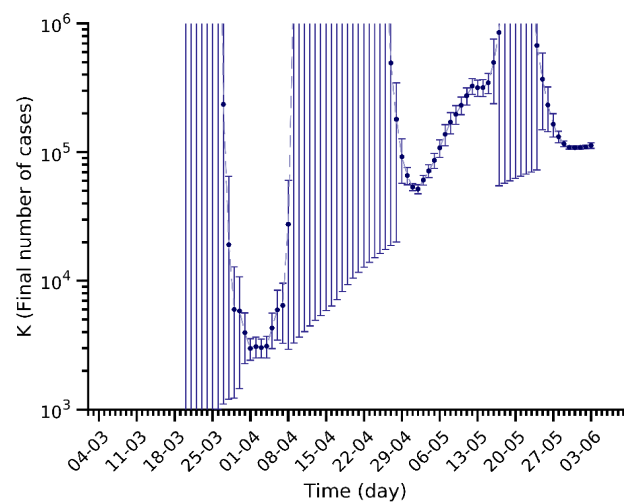
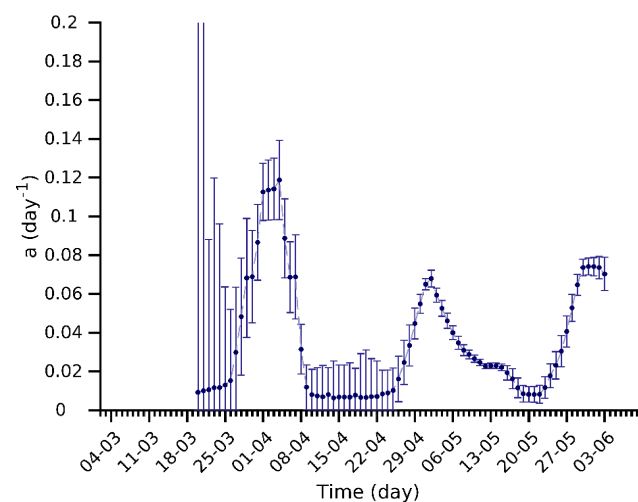
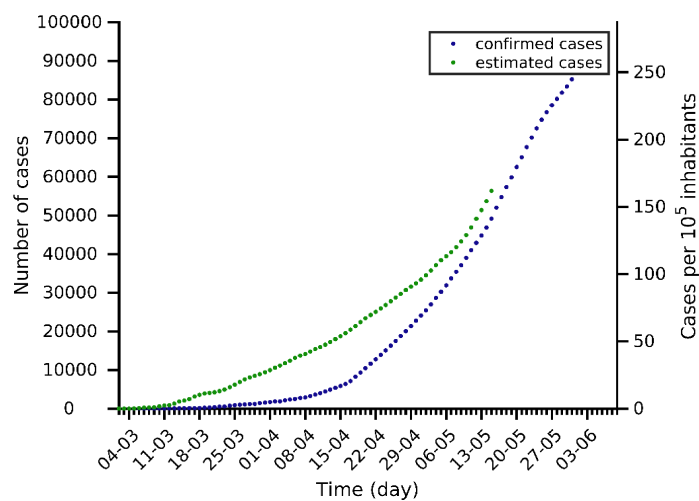
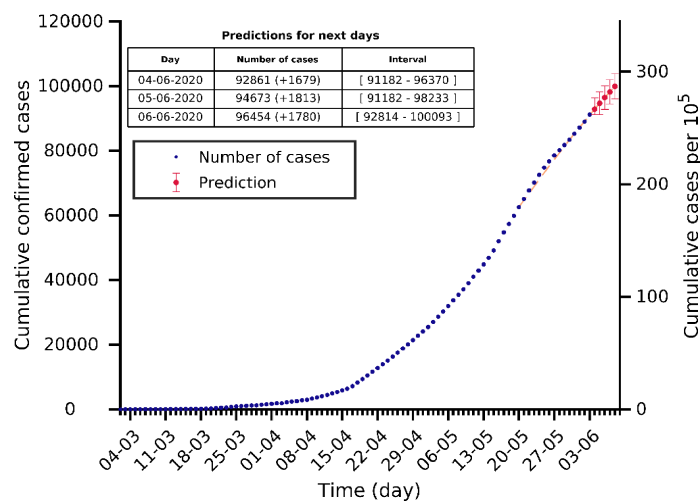


# Mexico 03-06-2020. Population: 128.9M. Current cumulated incidence: 79/10<sup>5</sup>

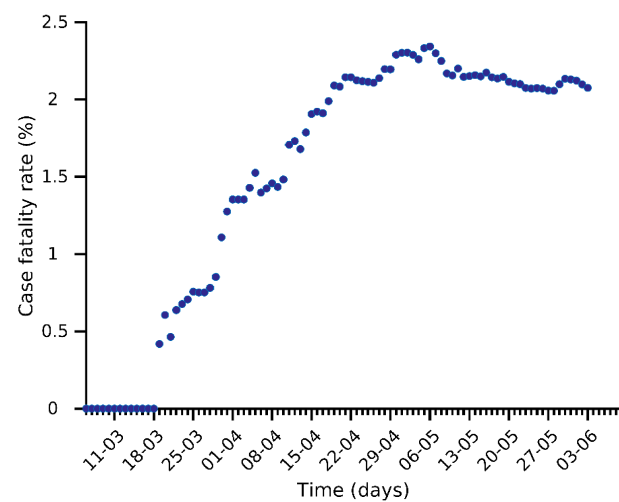
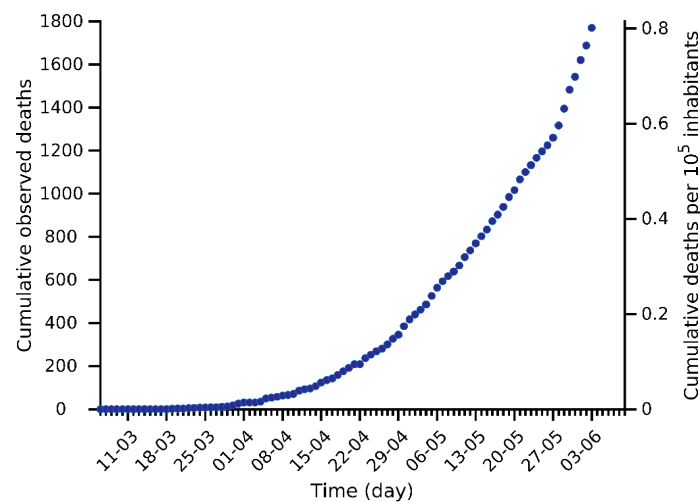
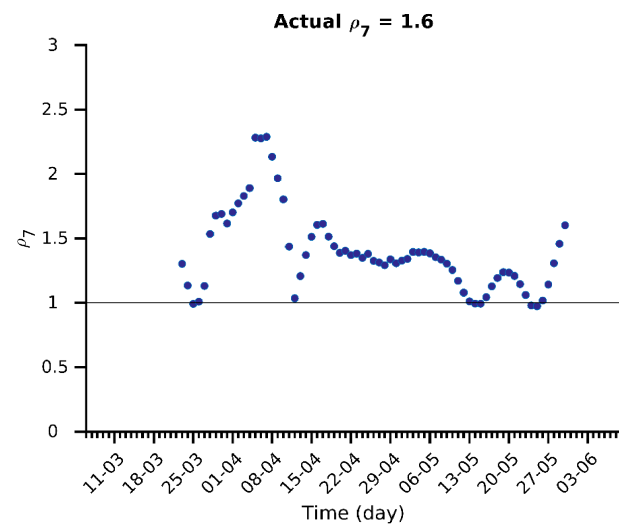
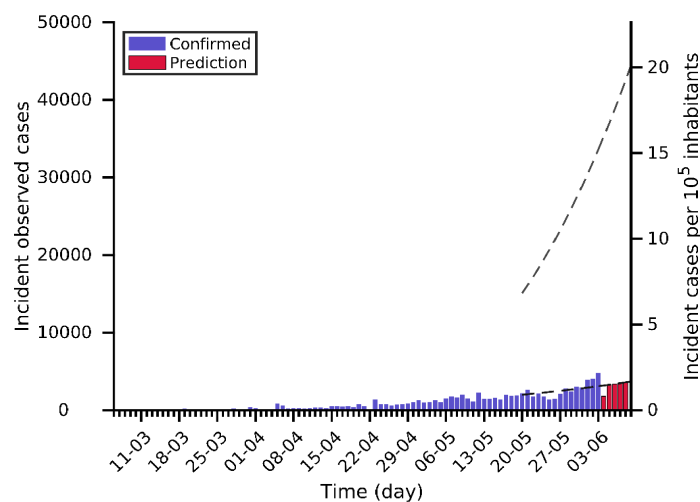
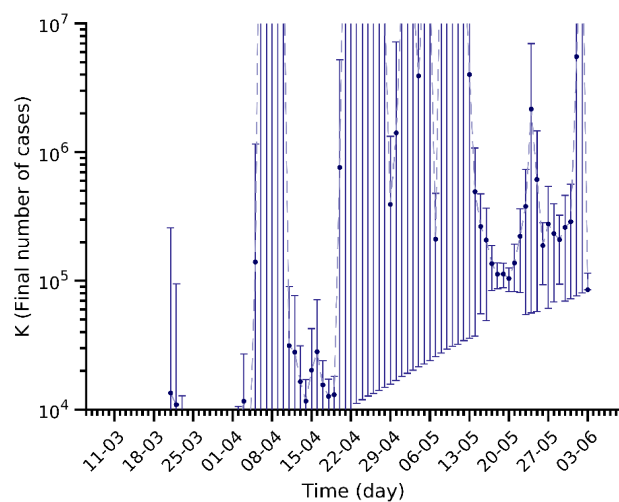
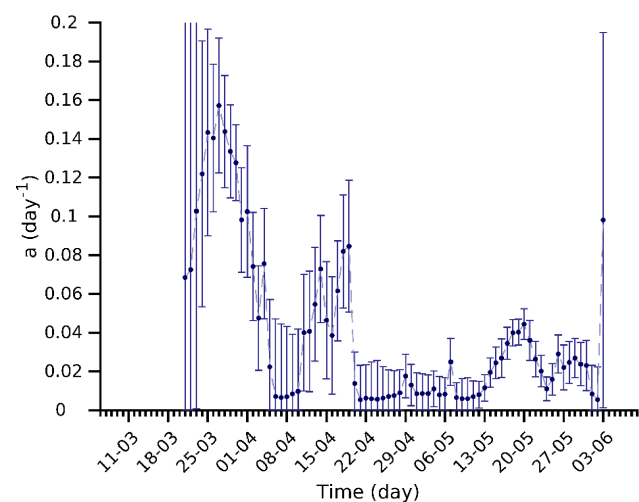
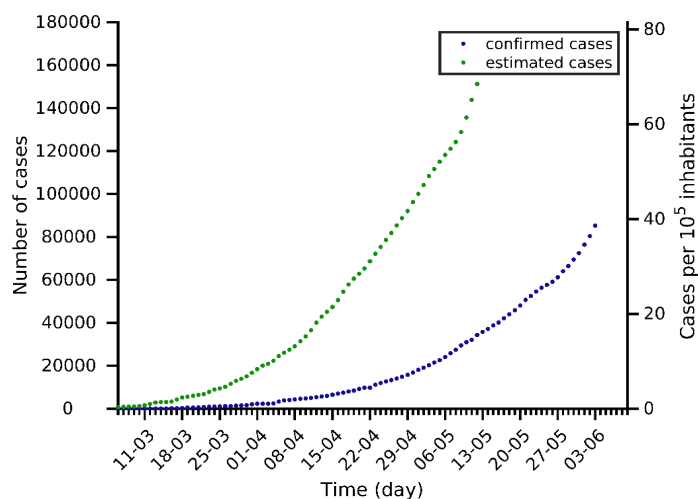
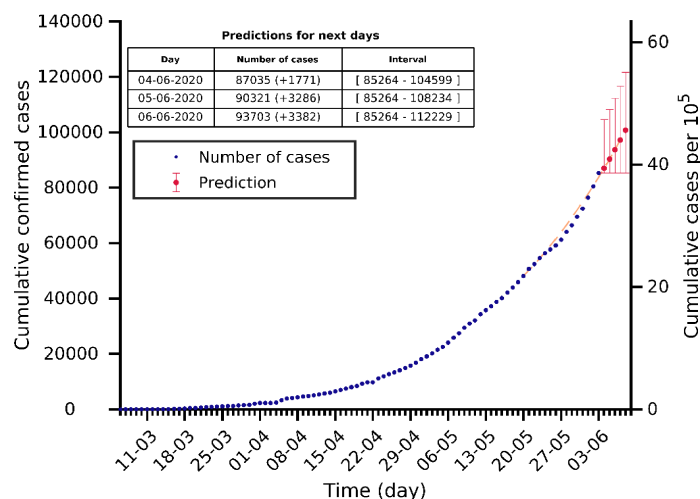


# Canada 03-06-2020. Population: 37.7M. Current cumulated incidence: 247/10<sup>5</sup>

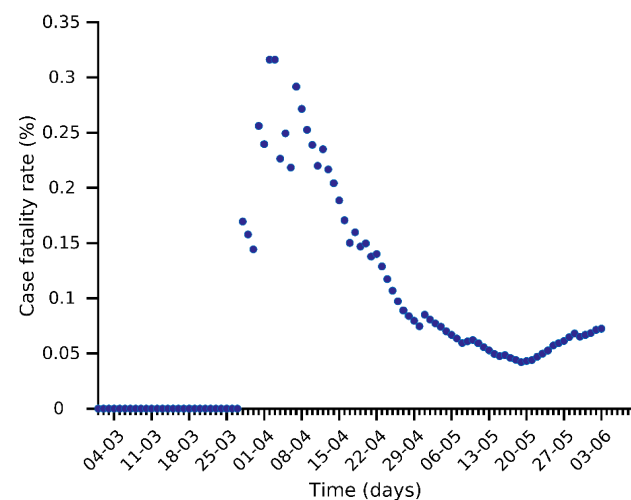
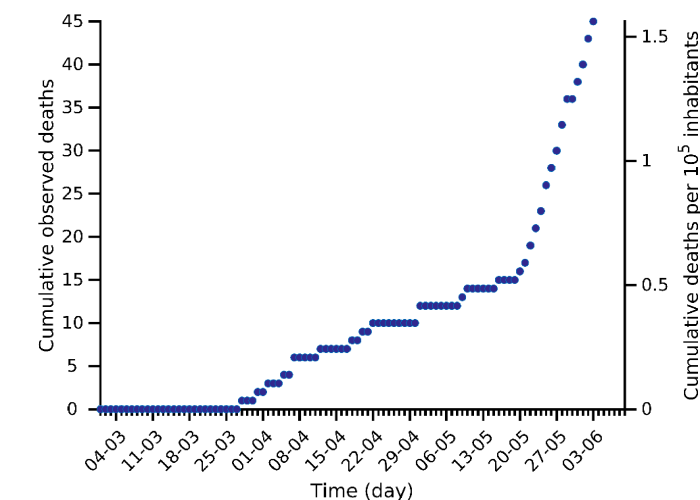
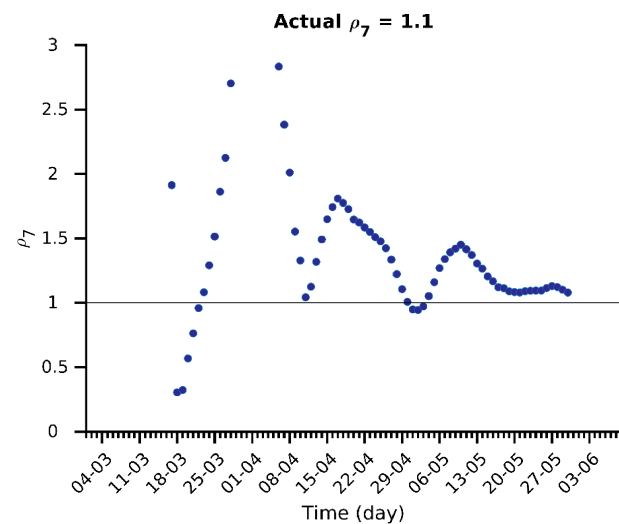
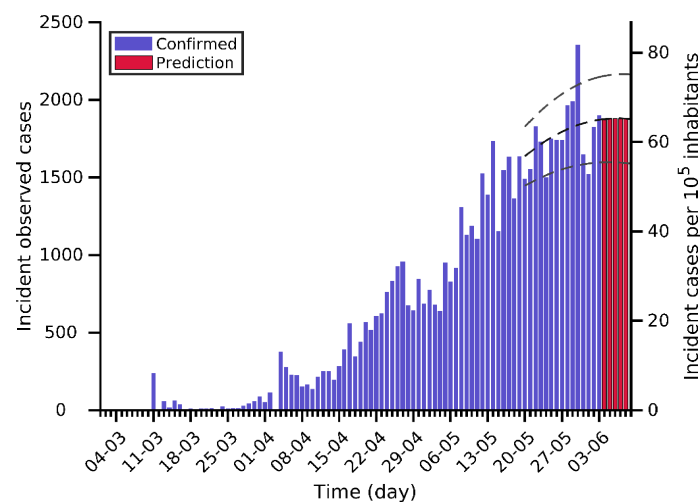
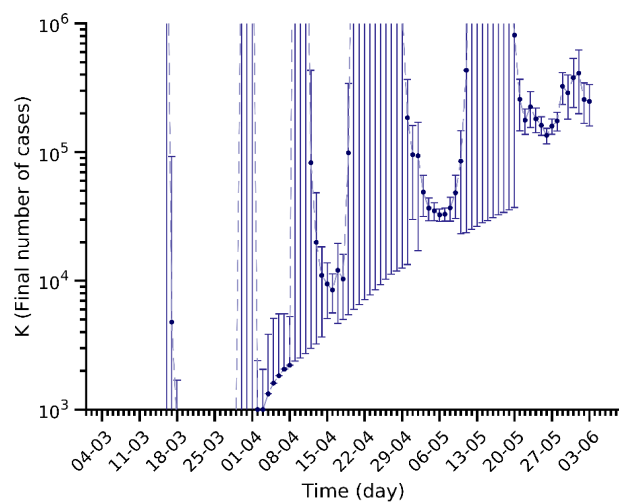
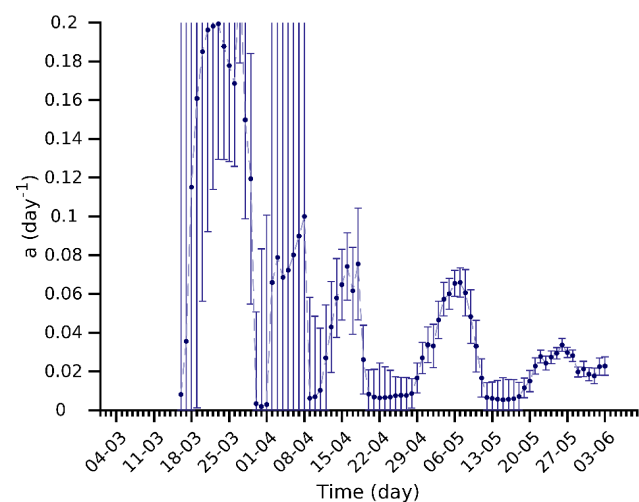
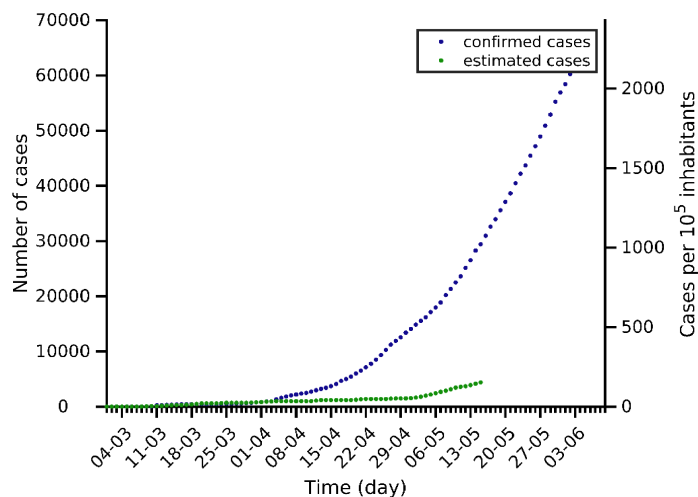
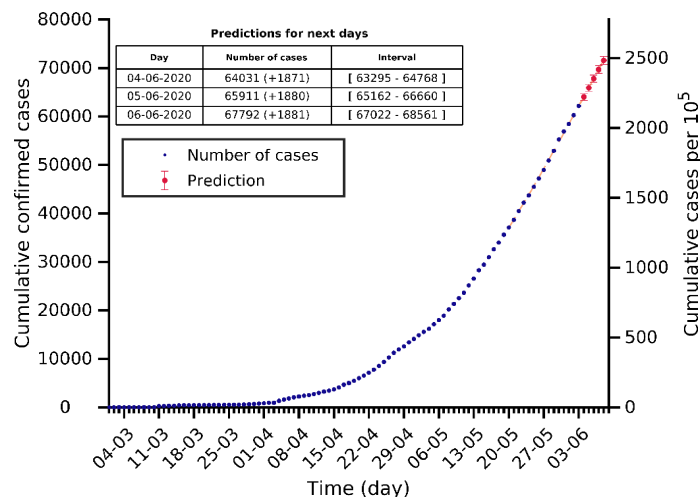




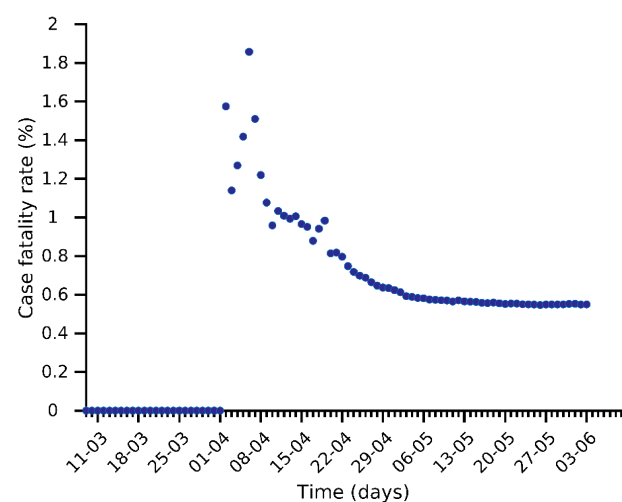
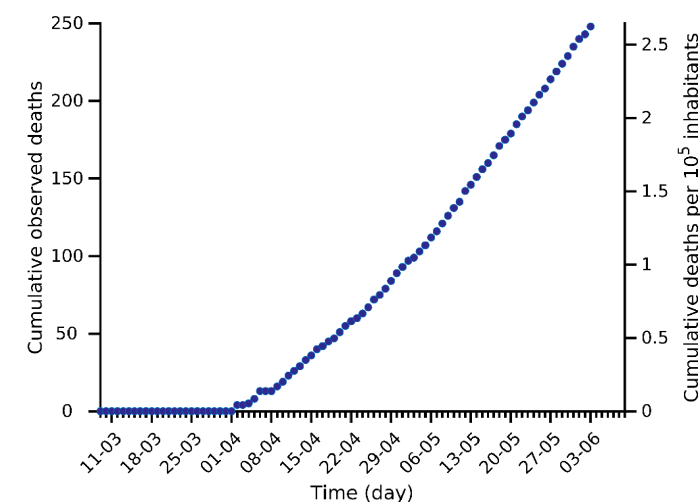
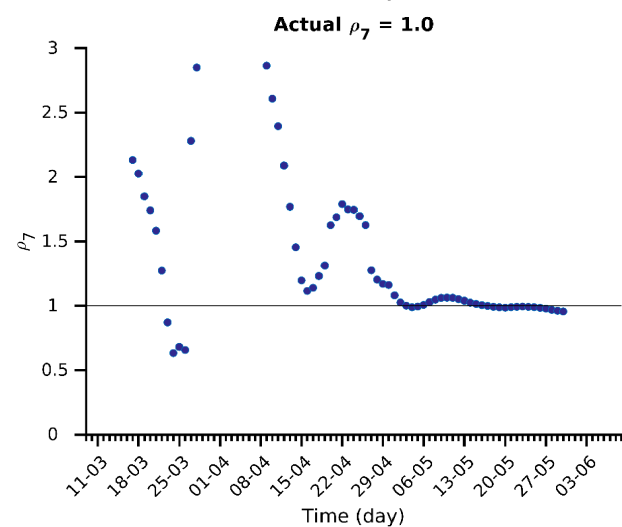
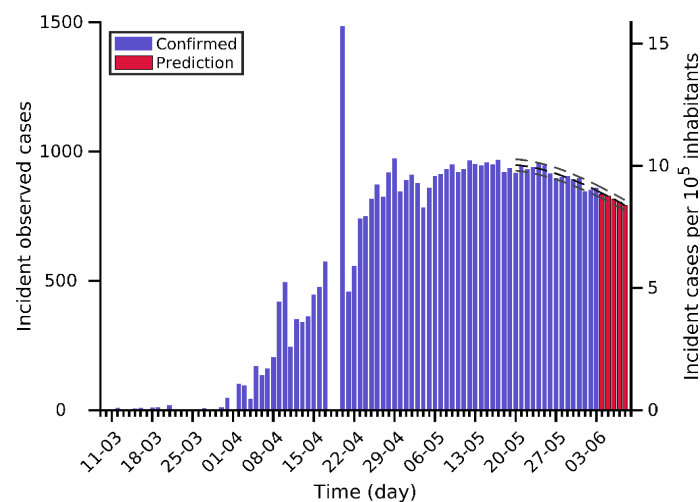
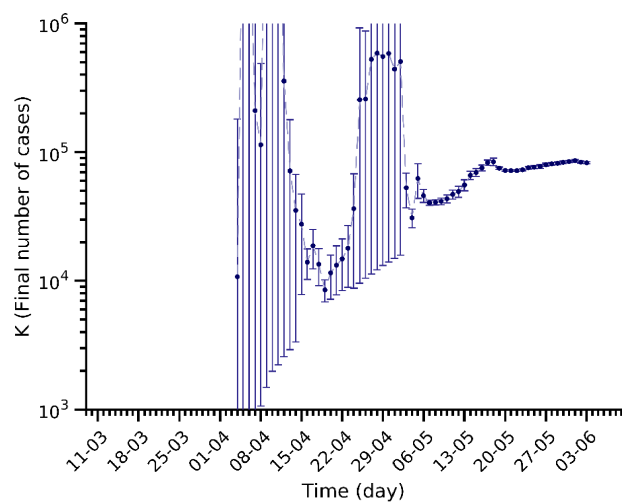
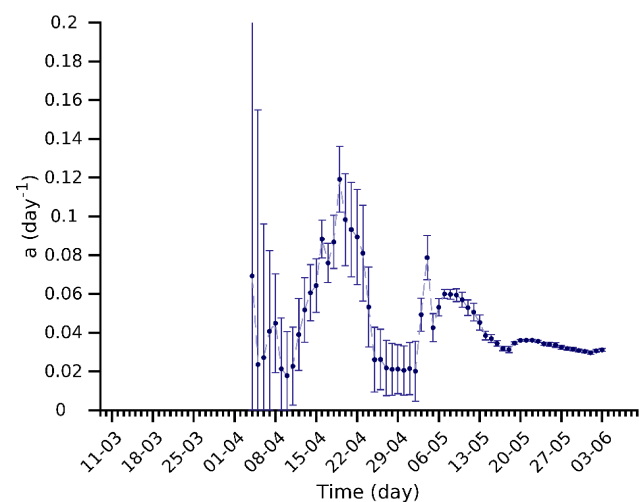
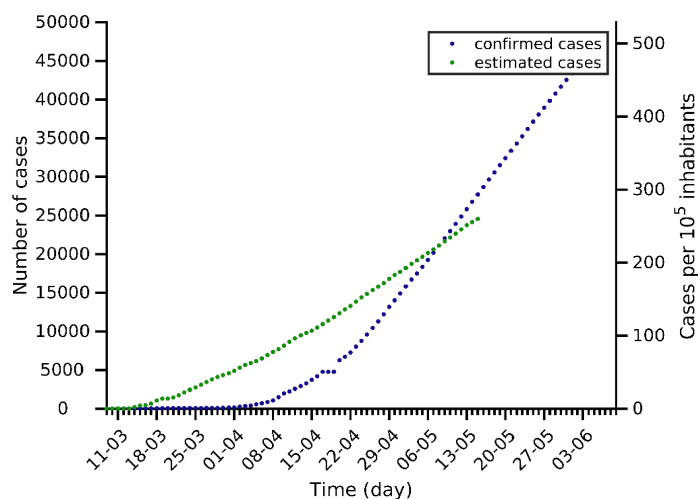
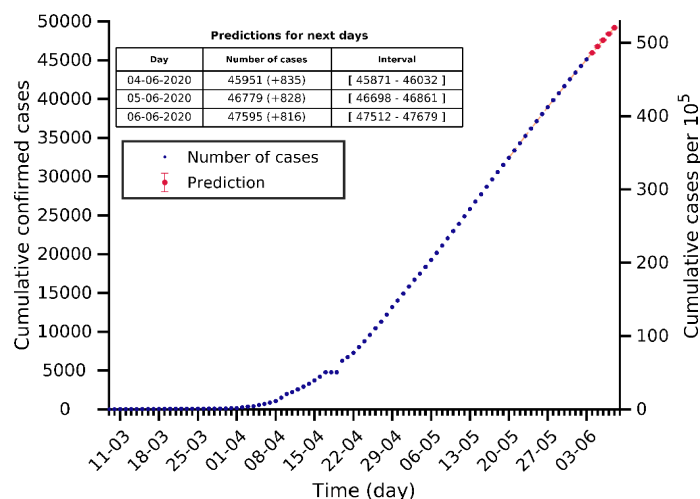
# Pakistan 03-06-2020. Population: 220.9M. Current cumulated incidence: 39/10<sup>5</sup>



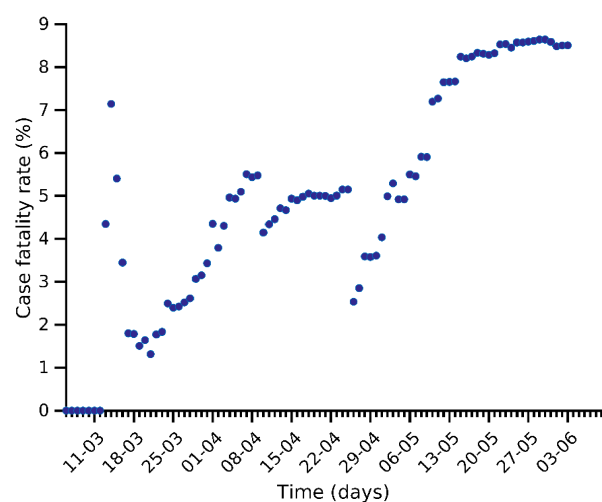
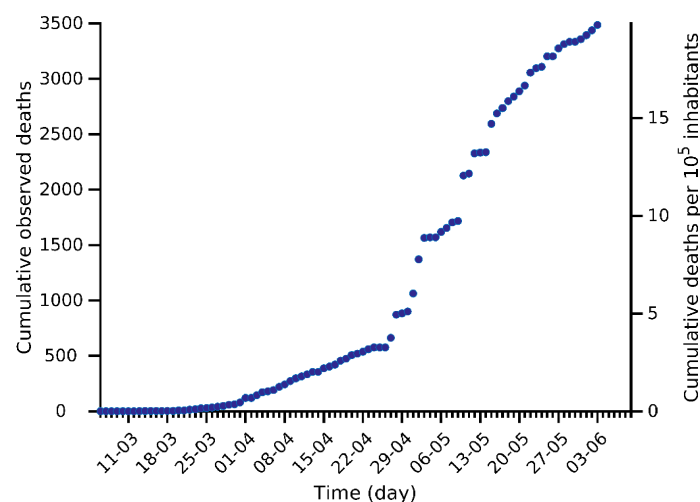
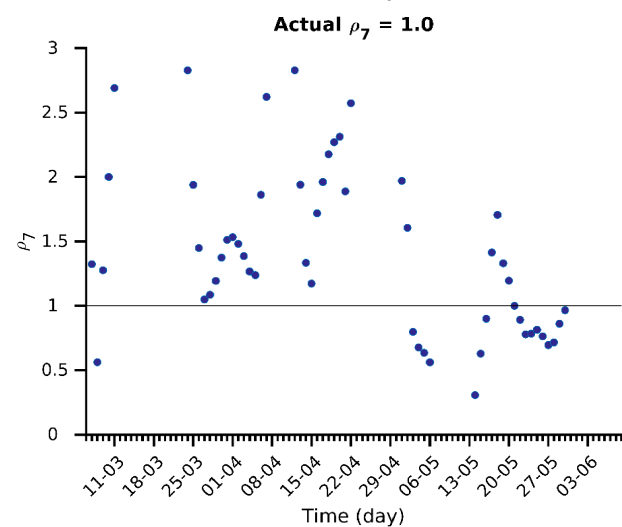
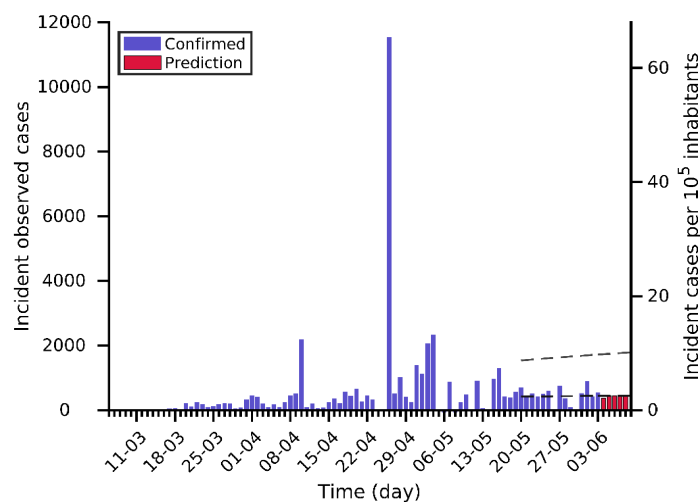
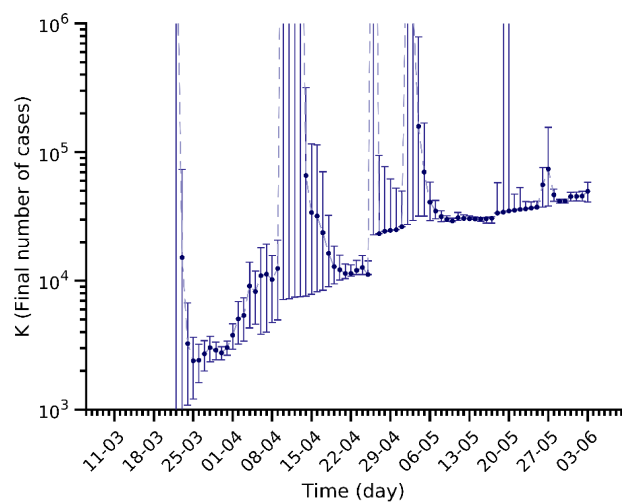
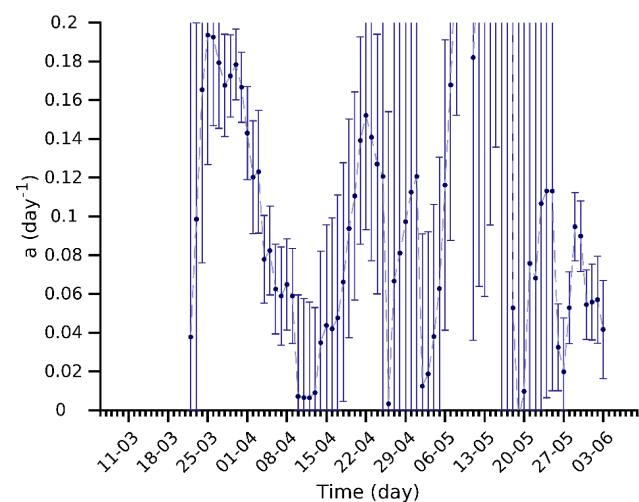
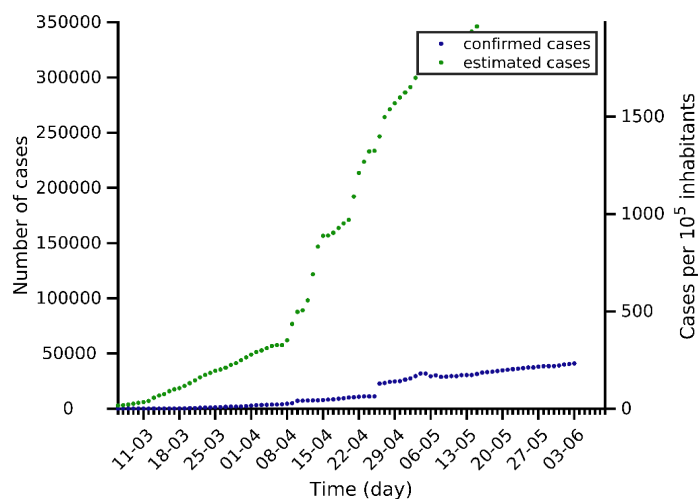
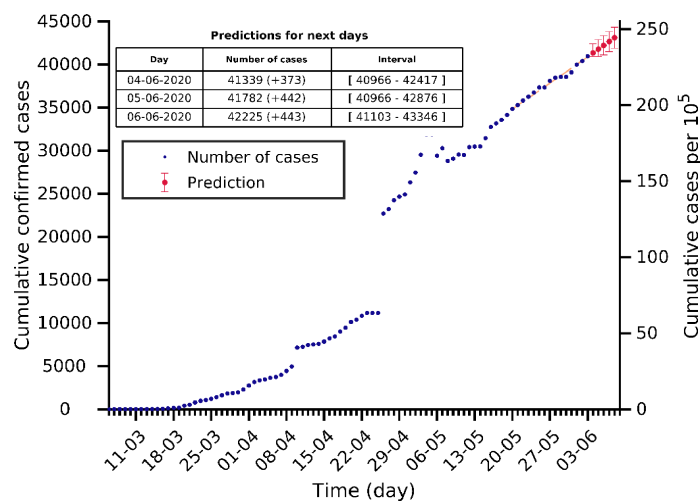
# Qatar 03-06-2020. Population: 2.9M. Current cumulated incidence: 2158/10<sup>5</sup>



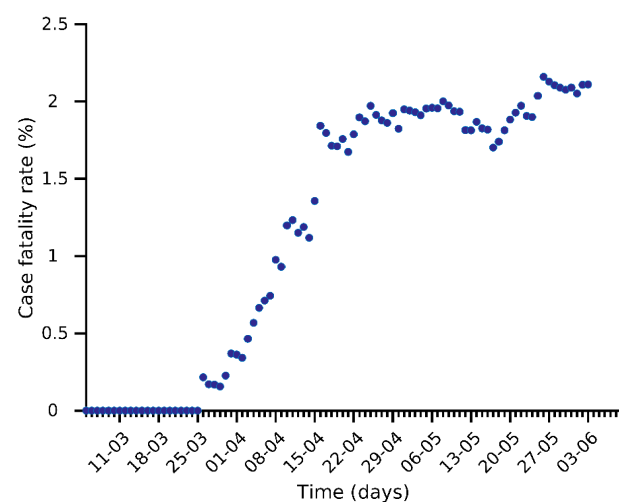
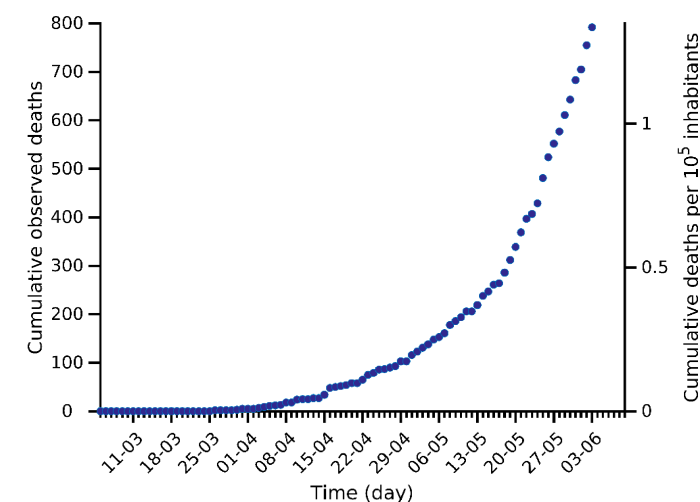
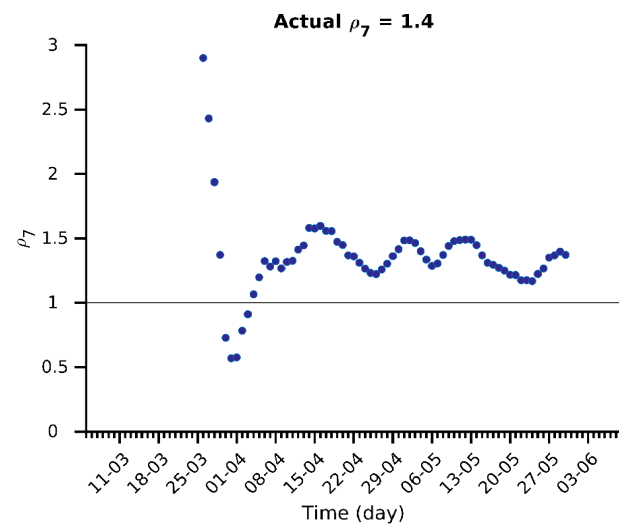
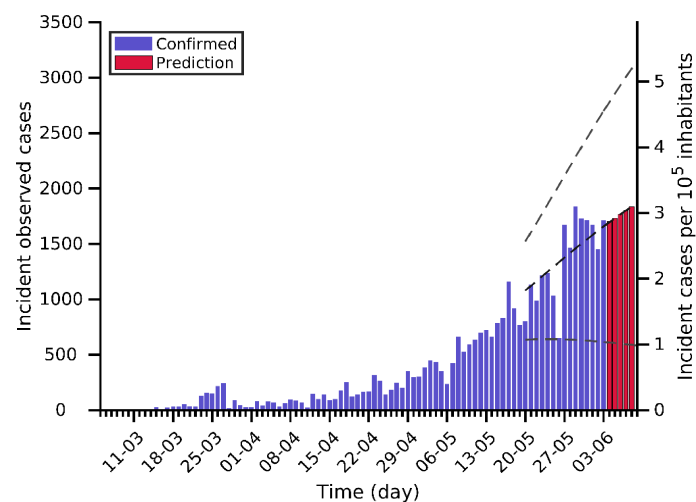
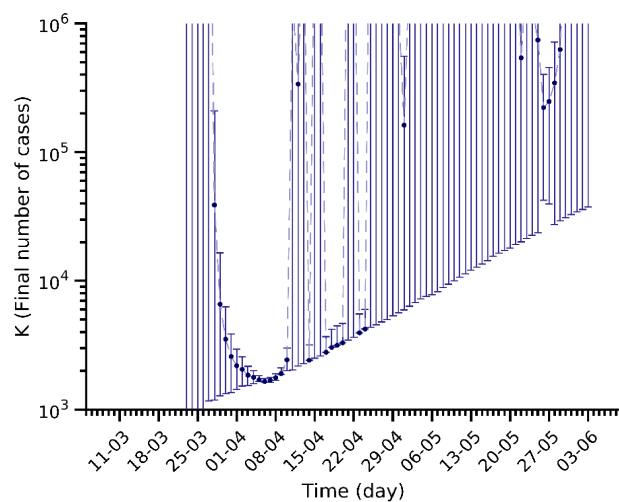
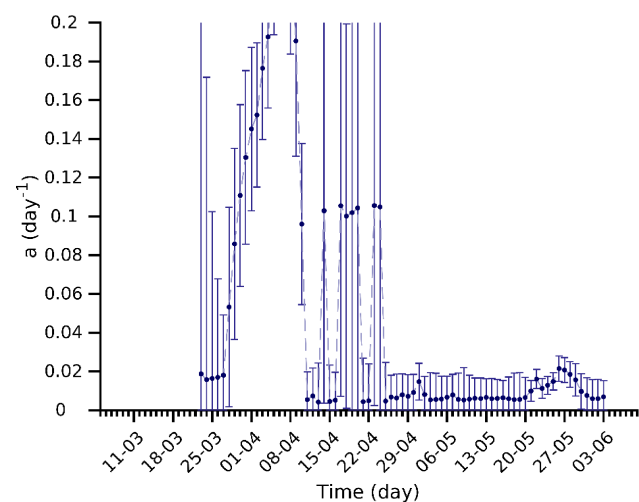
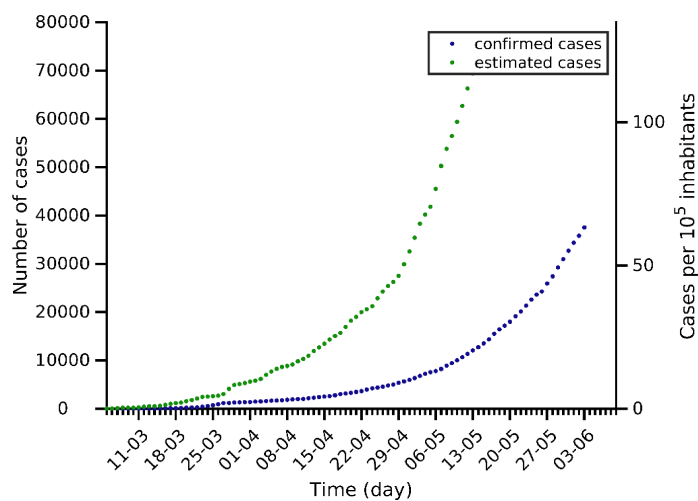
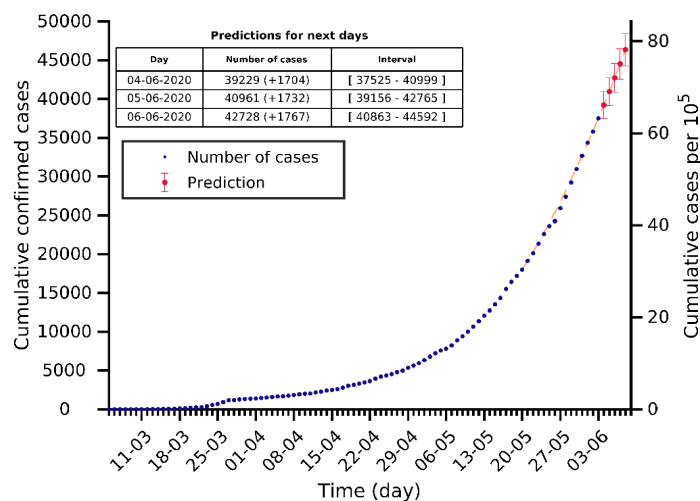
# Belarus 03-06-2020. Population: 9.4M. Current cumulated incidence: 477/10<sup>5</sup>



# Ecuador 03-06-2020. Population: 17.6M. Current cumulated incidence: 232/10<sup>5</sup>

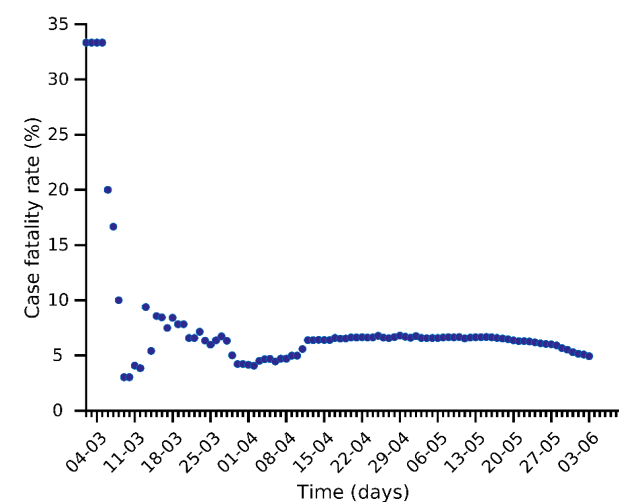
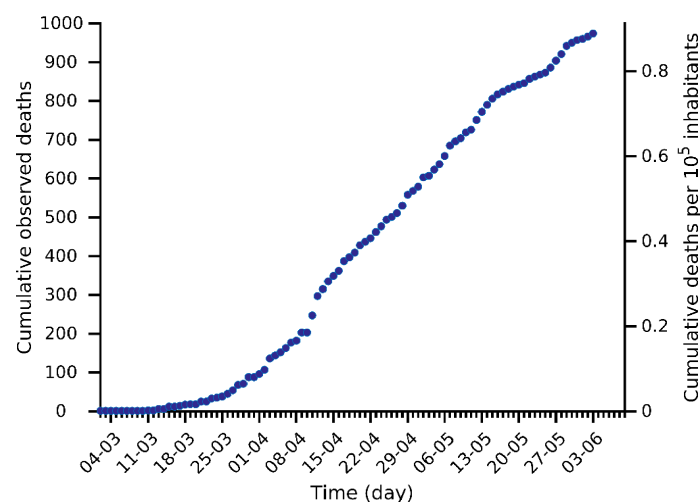
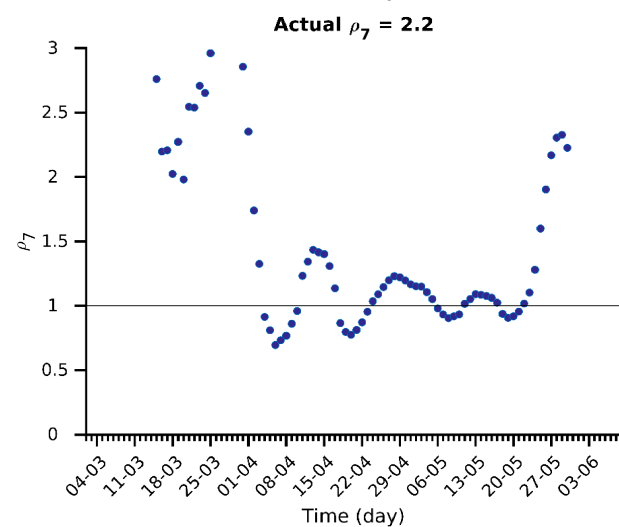
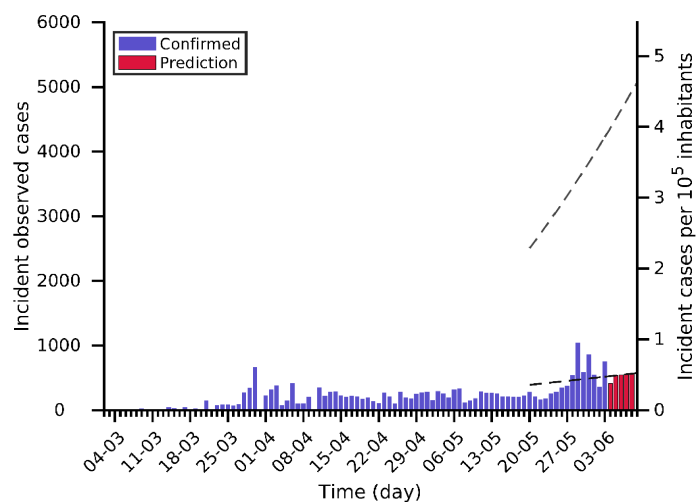
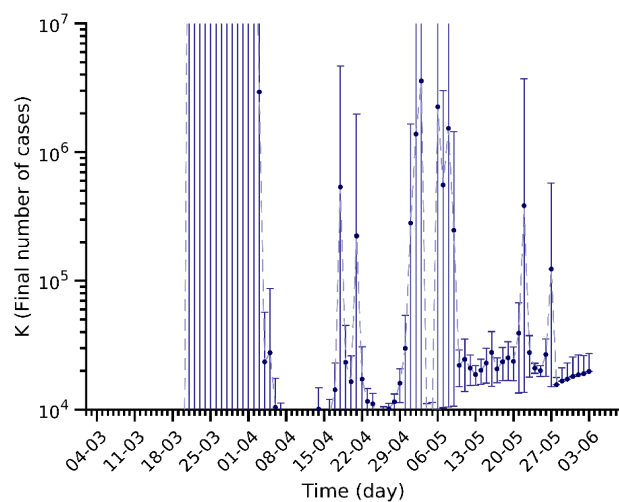
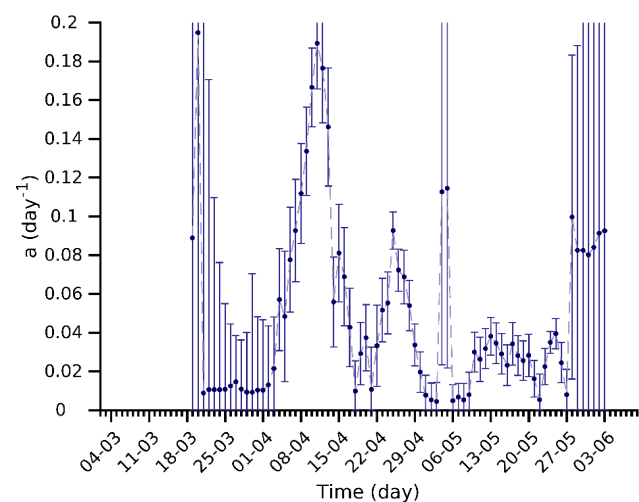
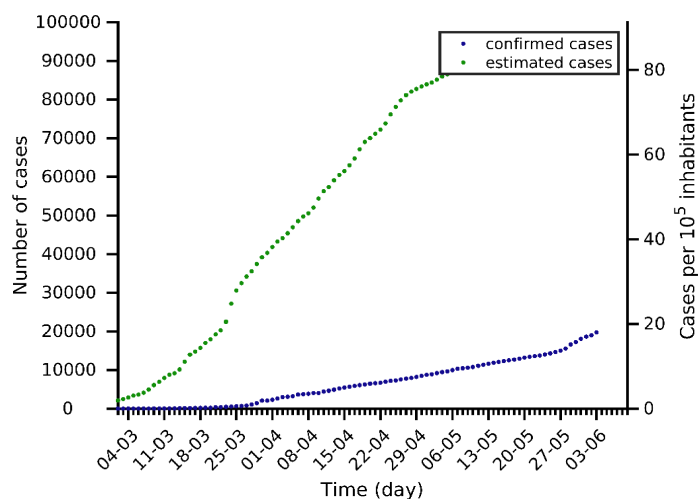
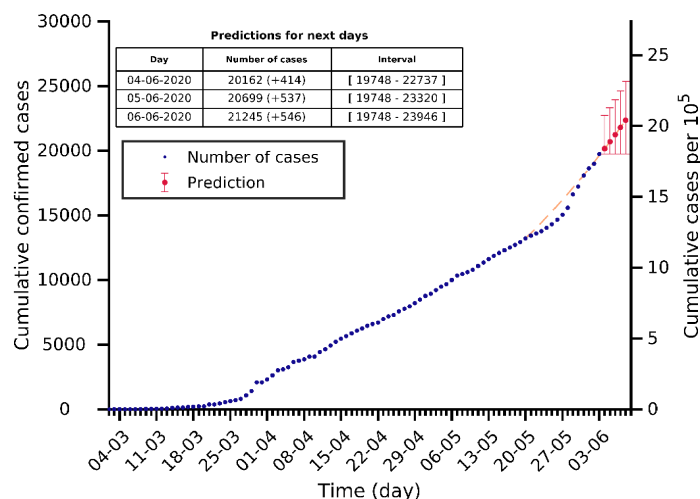


# South Africa 03-06-2020. Population: 59.3M. Current cumulated incidence: 63/10<sup>5</sup>

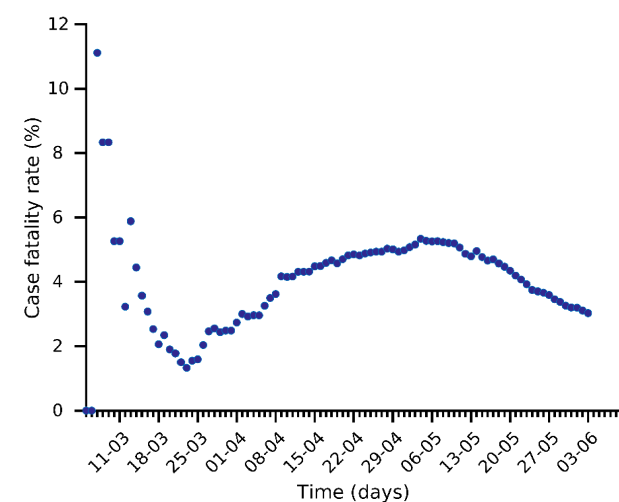
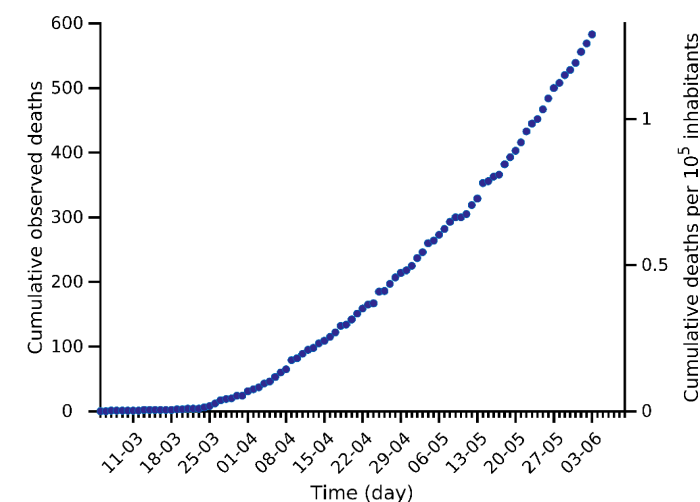
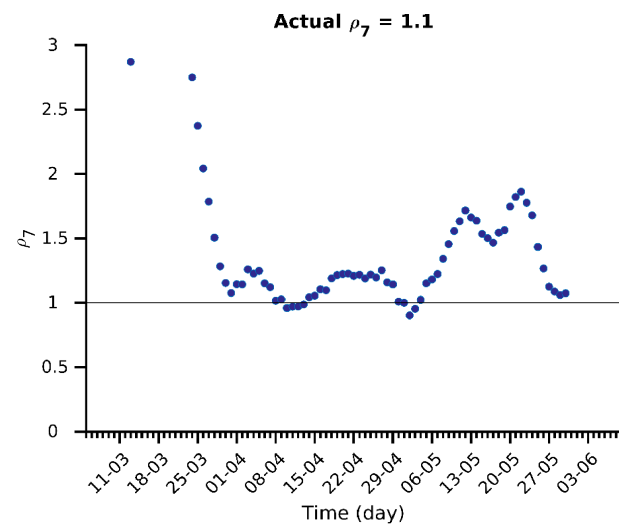
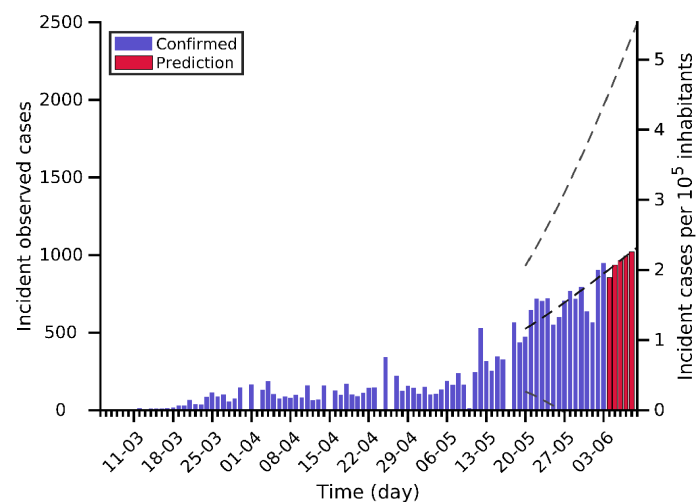
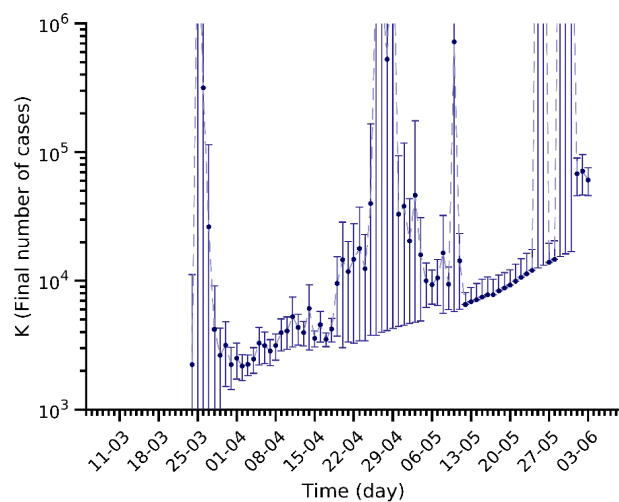
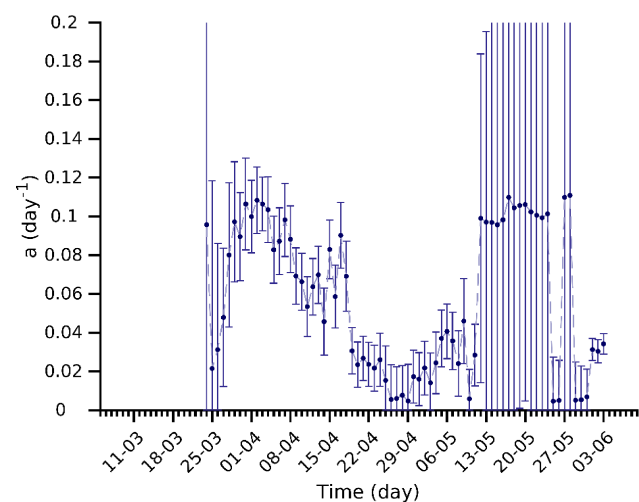
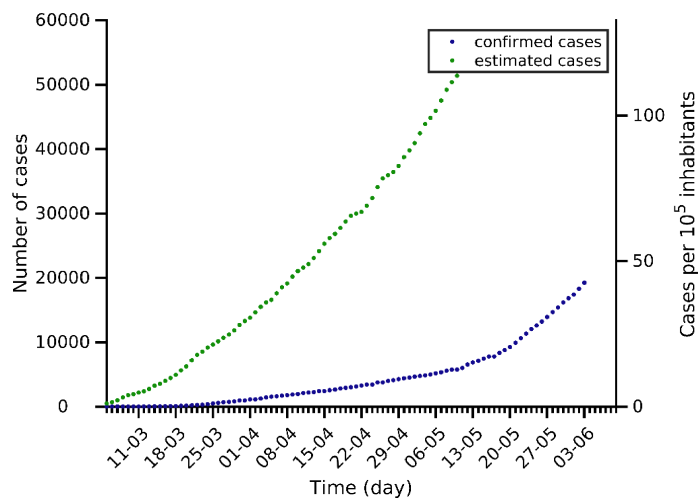
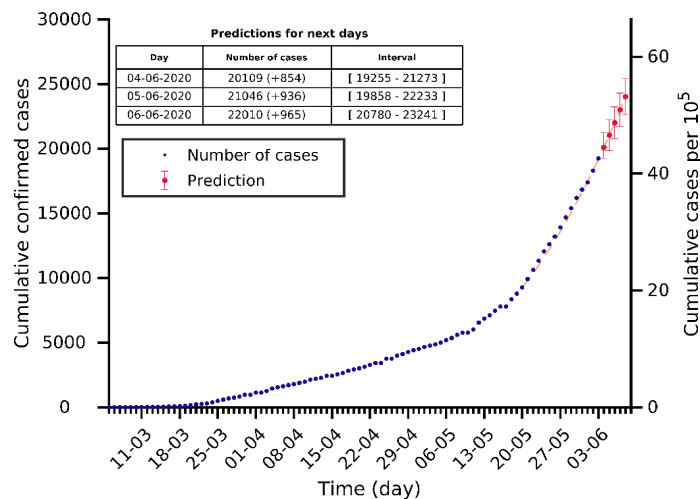




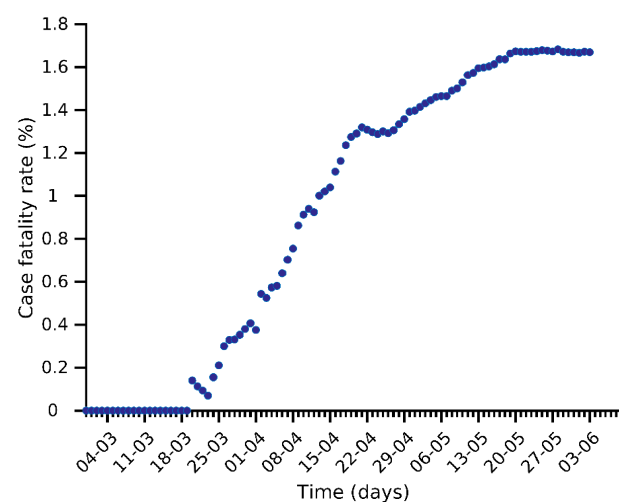
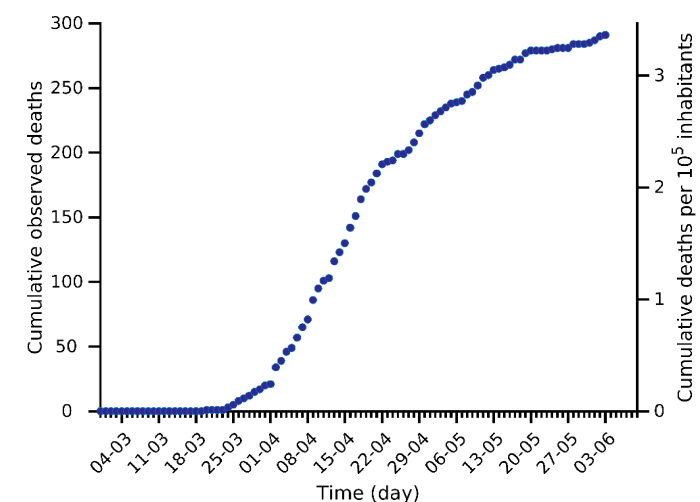
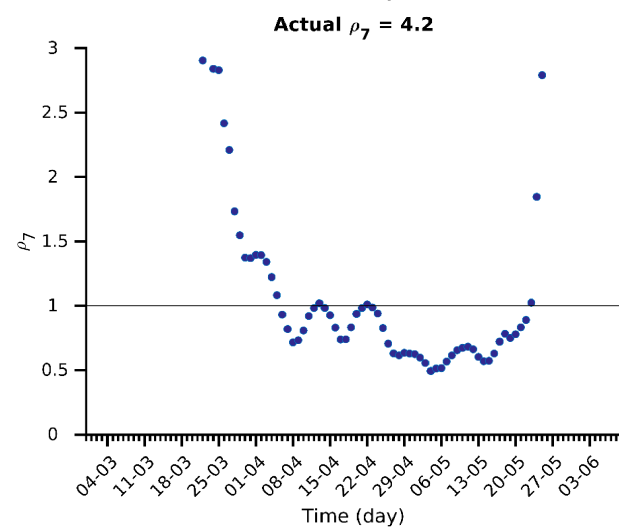
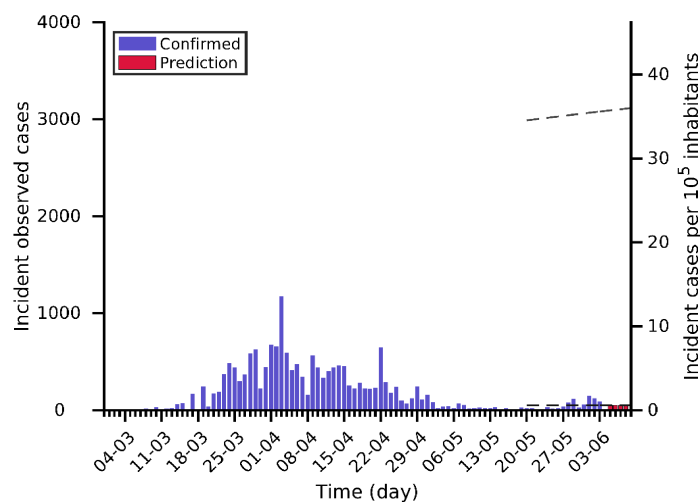
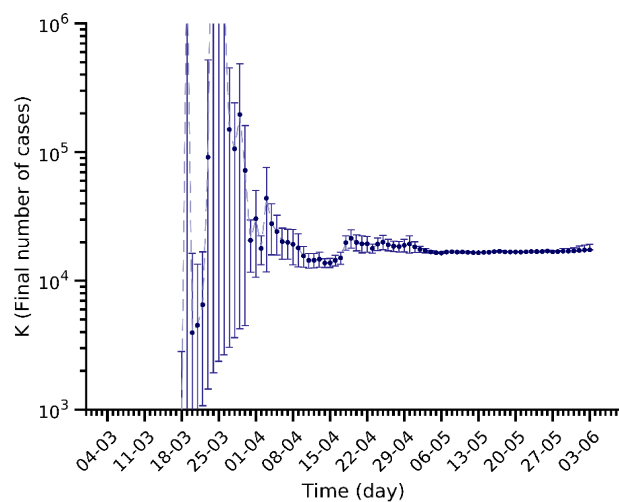
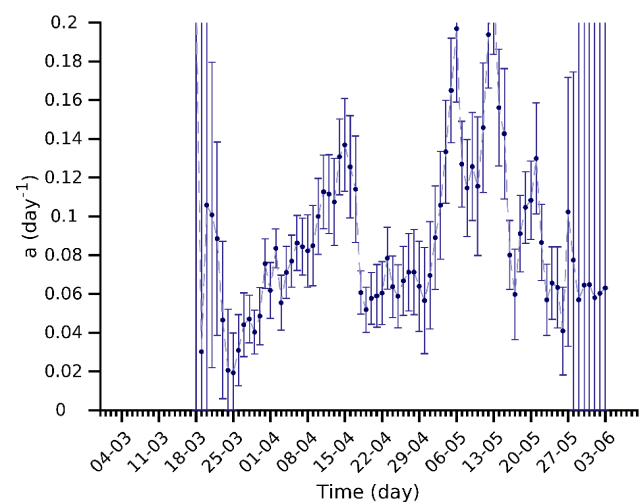
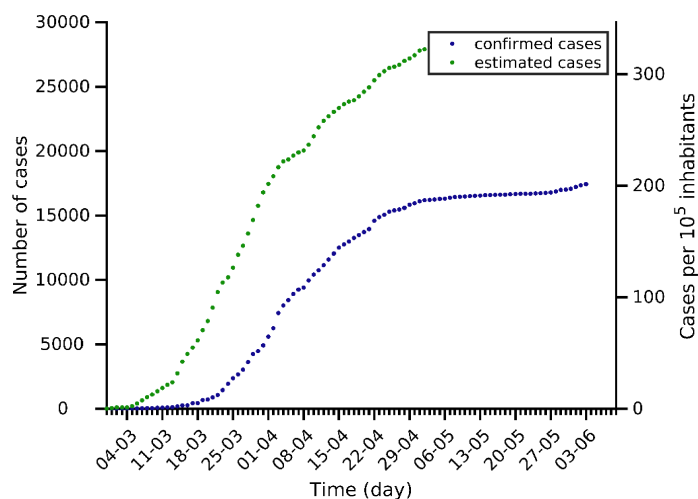
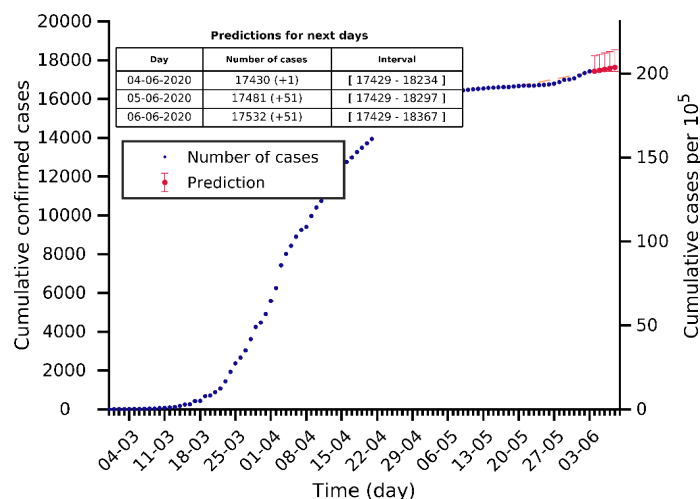
# Philippines 03-06-2020. Population: 109.6M. Current cumulated incidence: 18/10<sup>5</sup>



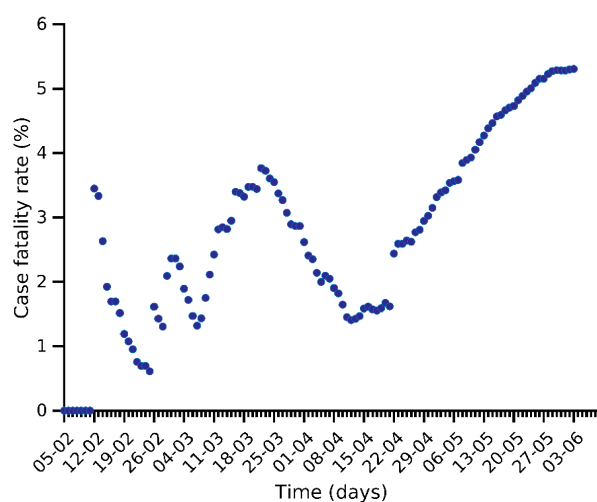
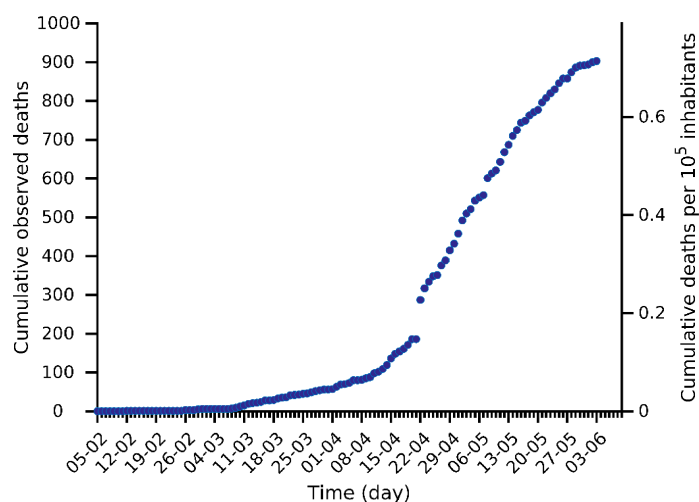
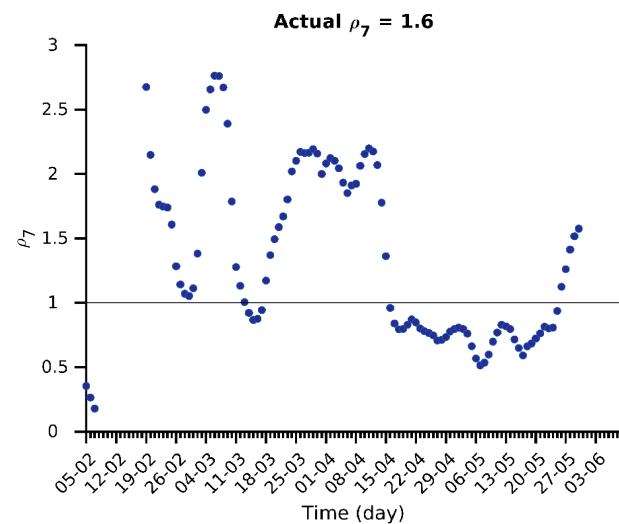
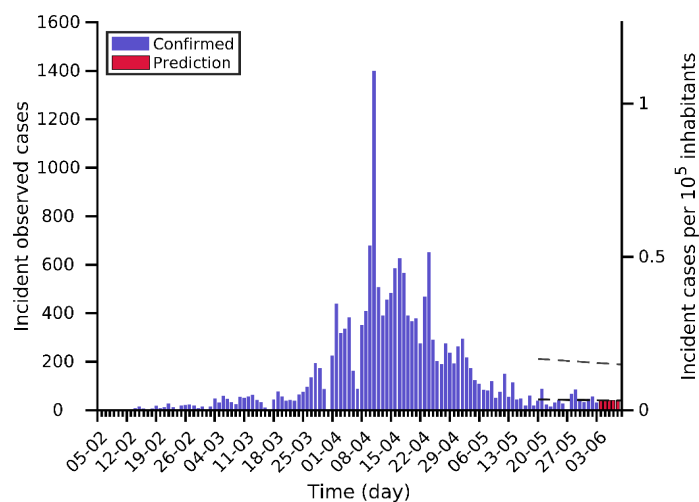
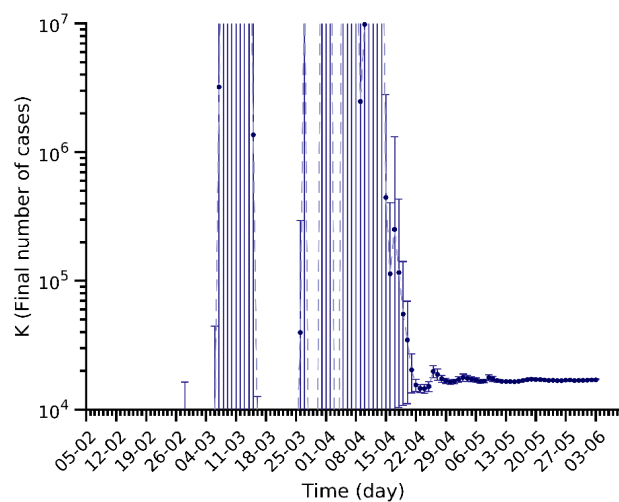
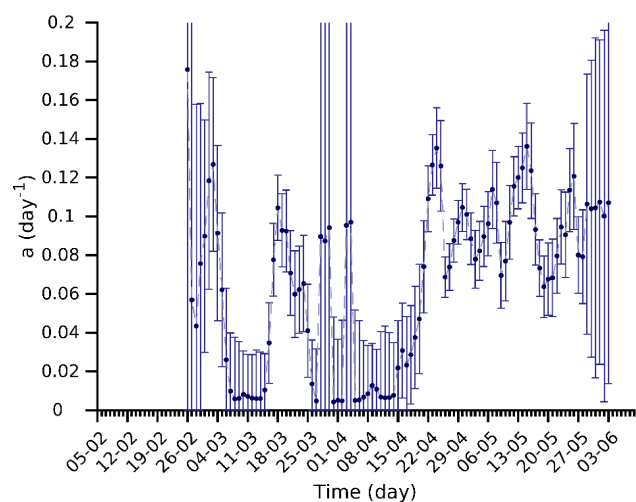
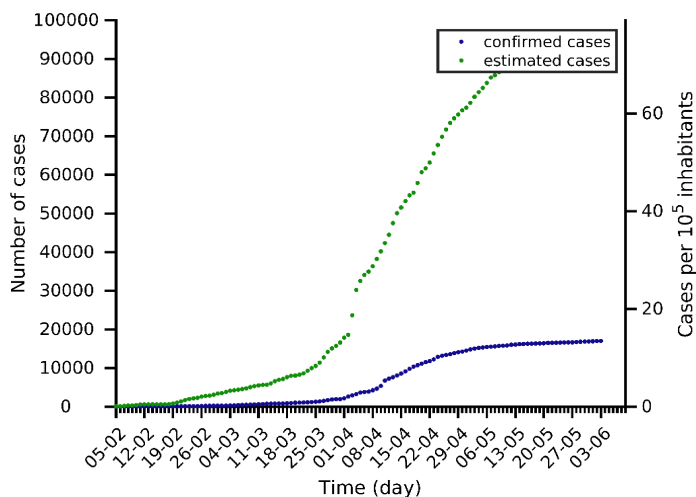
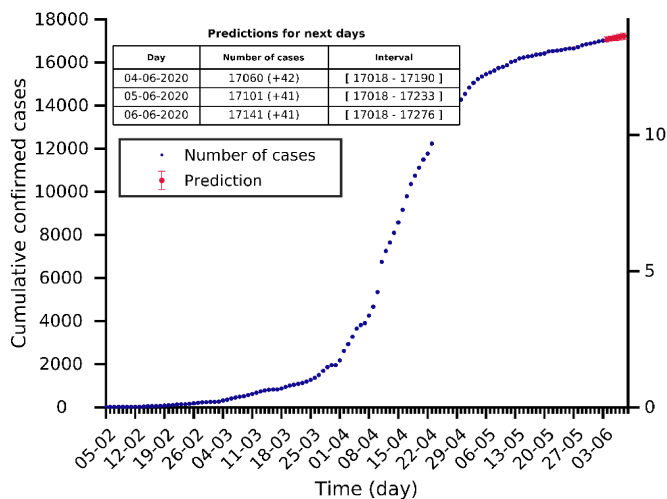
# Argentina 03-06-2020. Population: 45.2M. Current cumulated incidence: 43/10<sup>5</sup>



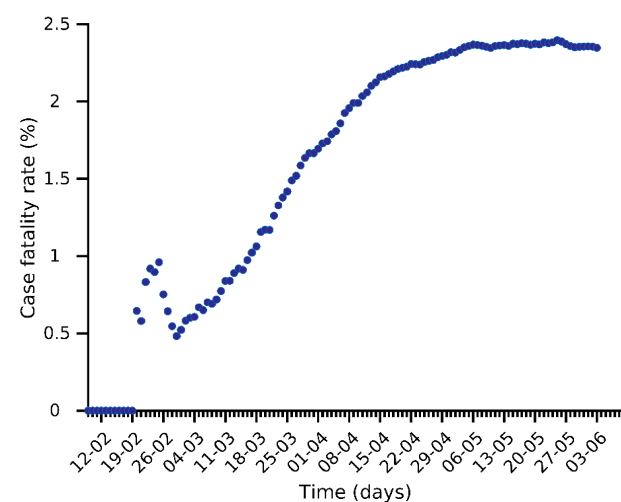
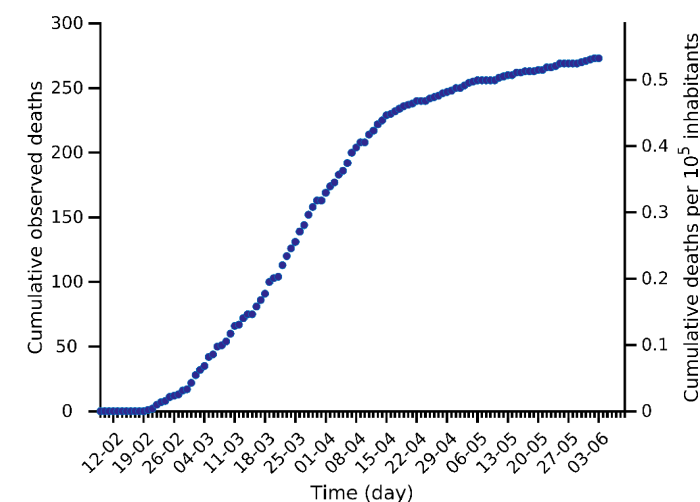
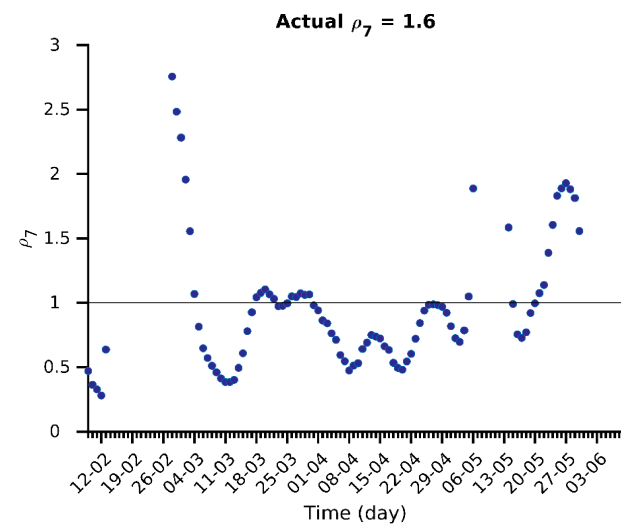
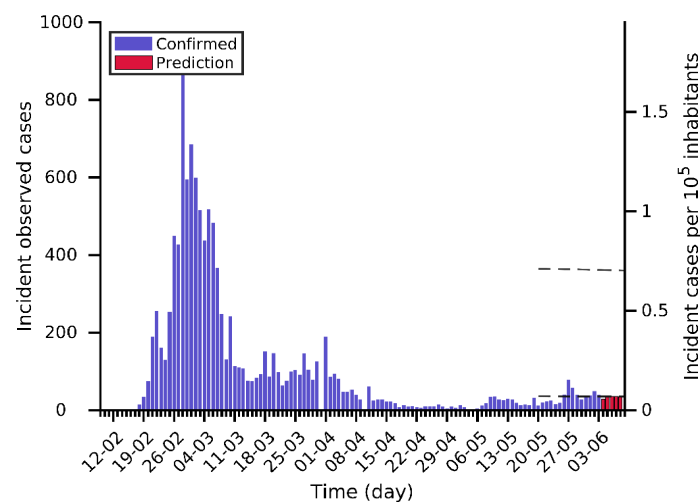
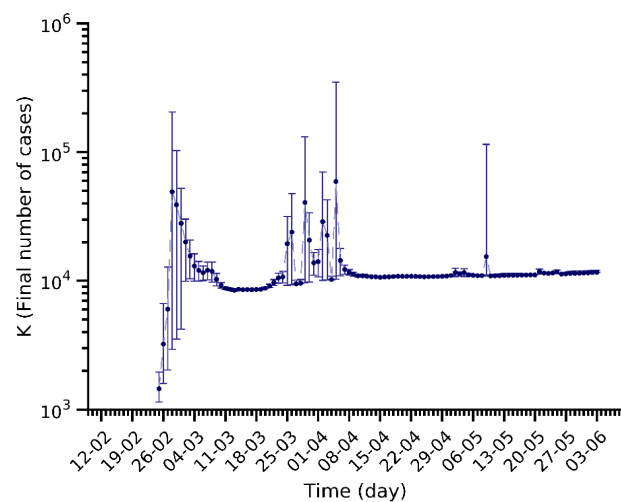
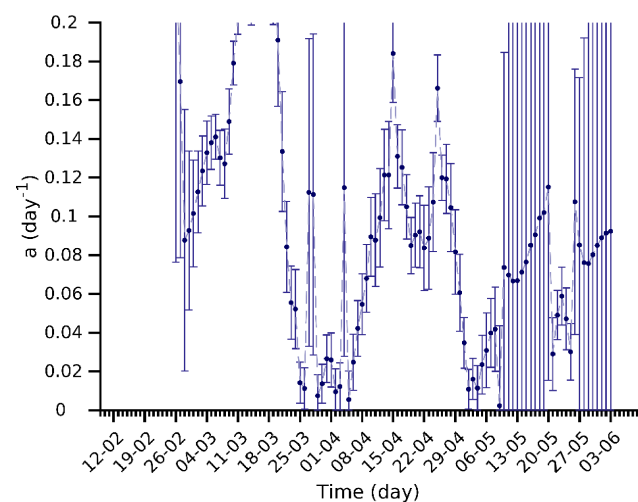
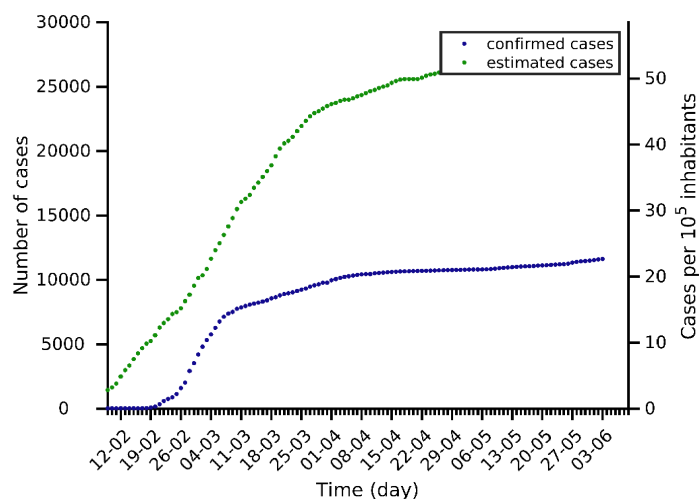
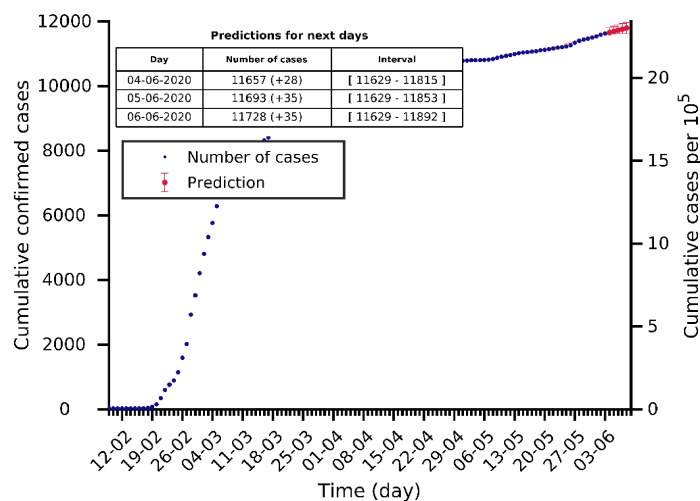
# Israel 03-06-2020. Population: 8.7M. Current cumulated incidence: 201/10<sup>5</sup>



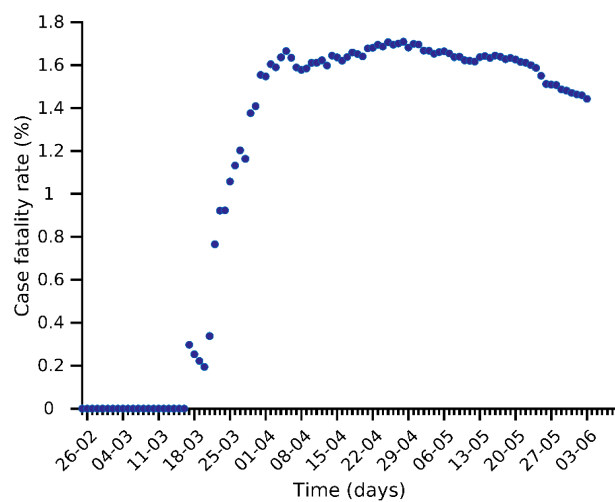
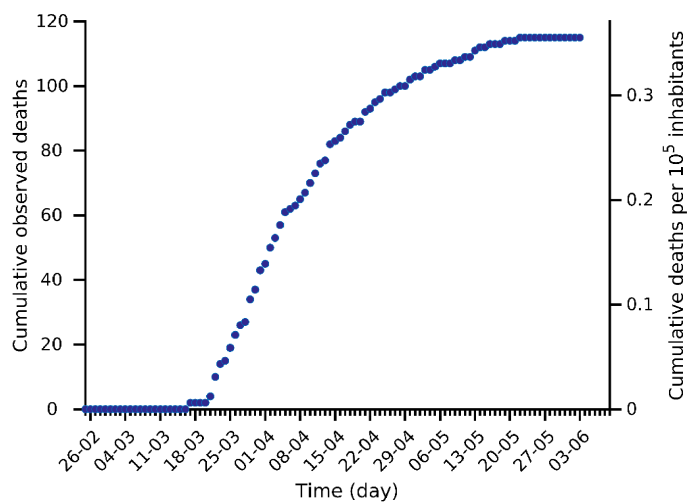
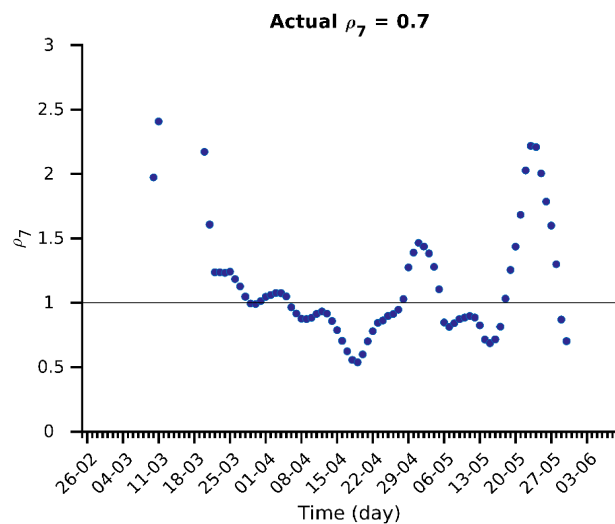
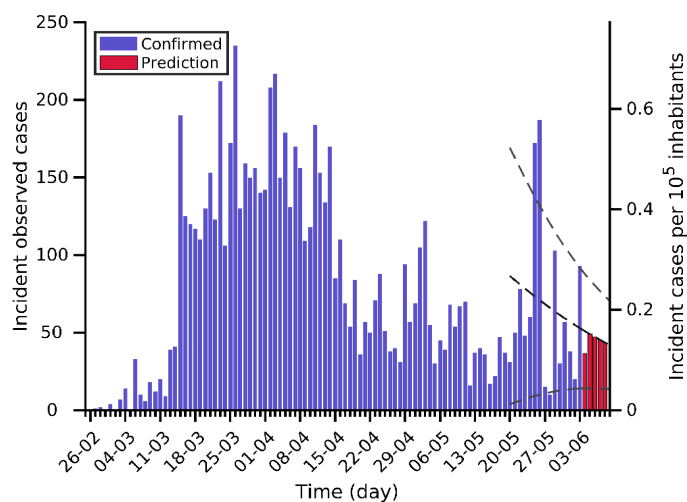
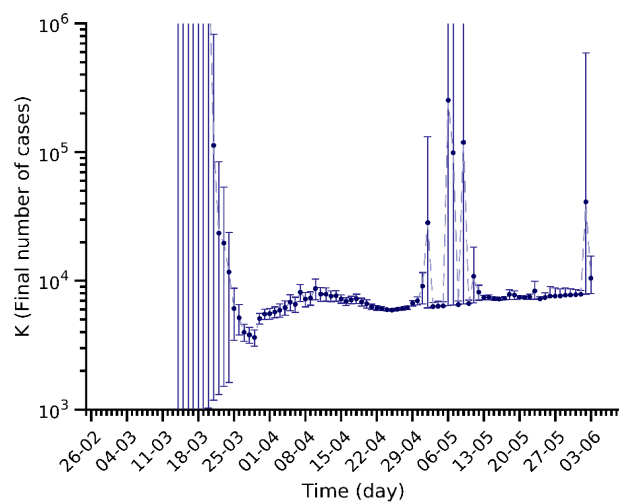
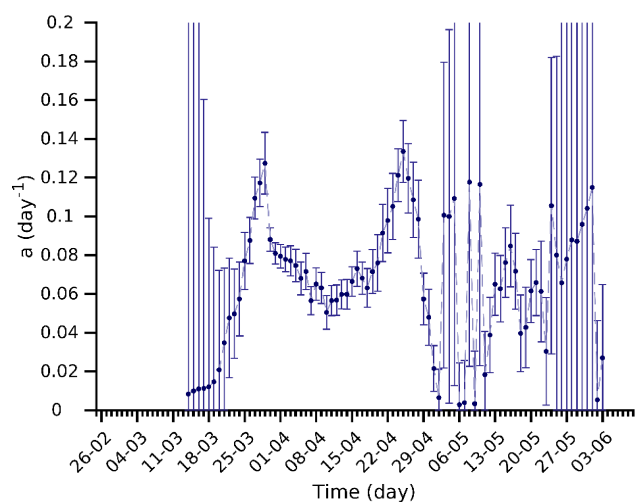
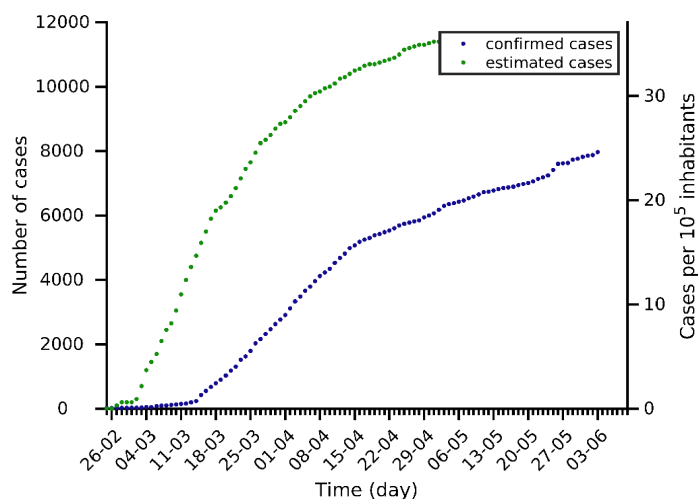
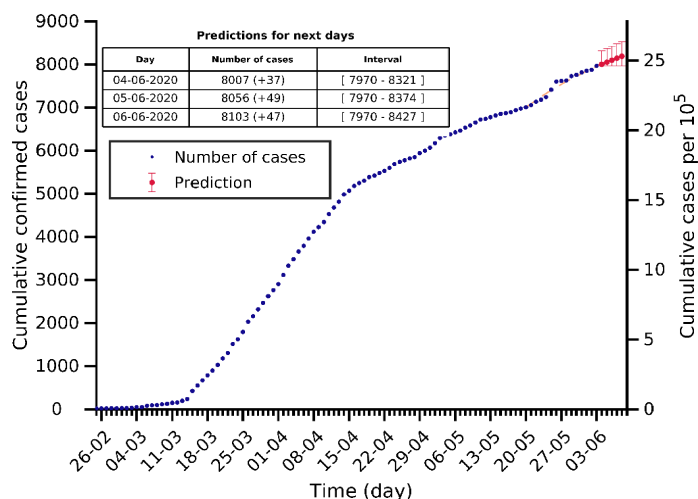
# Japan 03-06-2020. Population: 126.5M. Current cumulated incidence: 13/10<sup>5</sup>



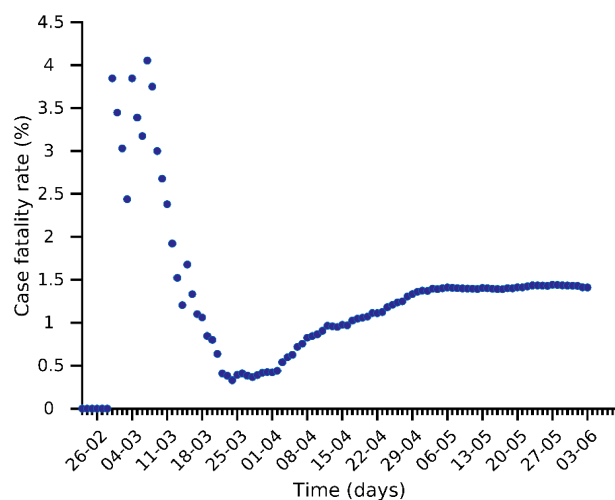
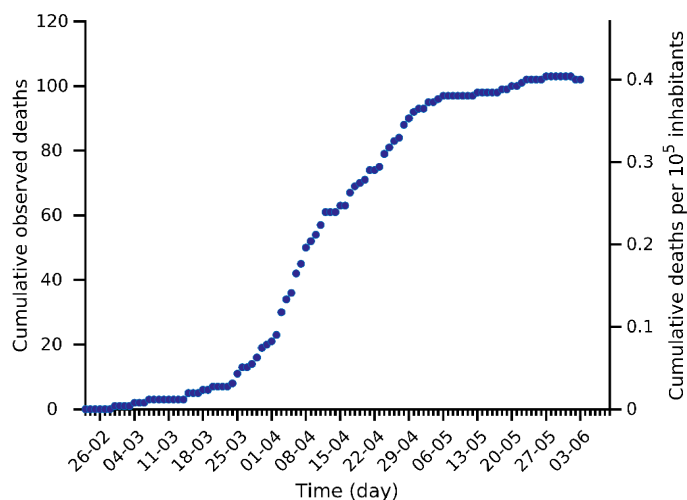
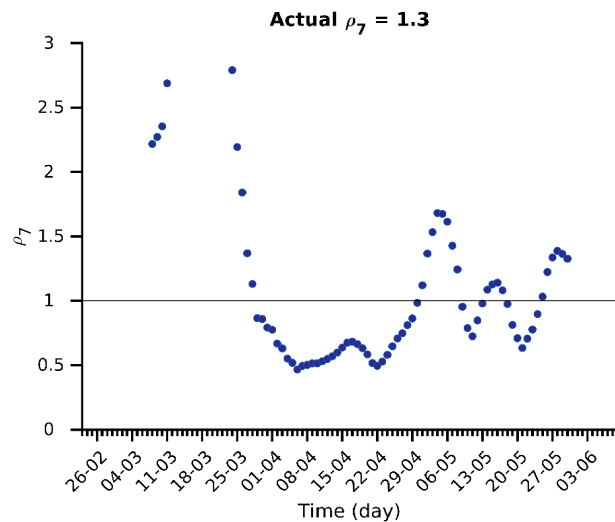
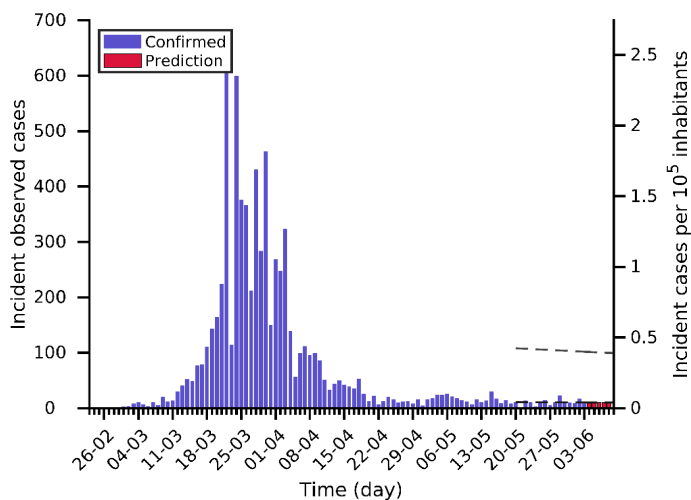
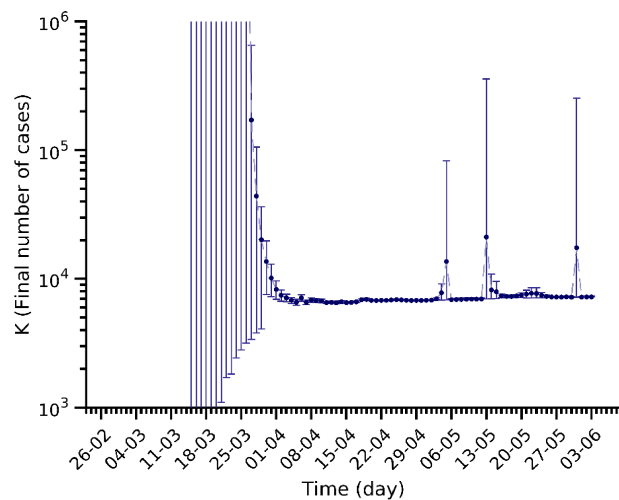
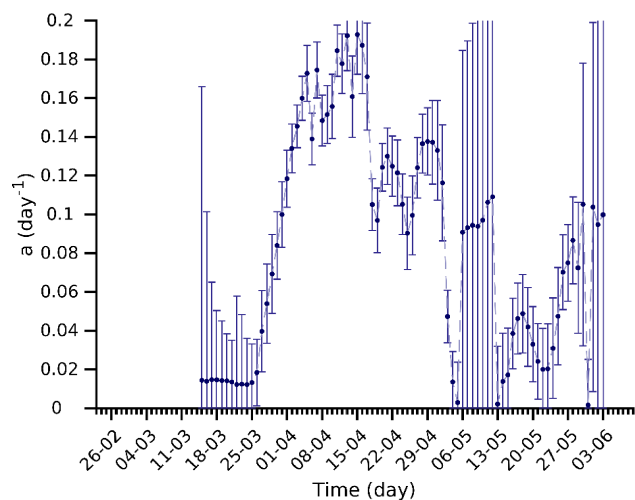
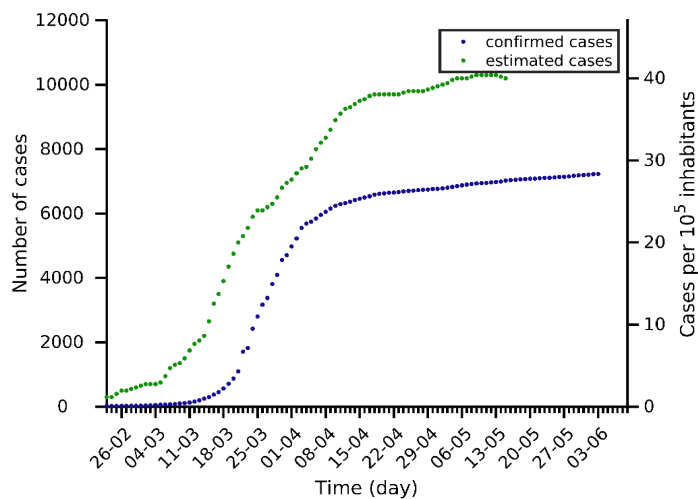
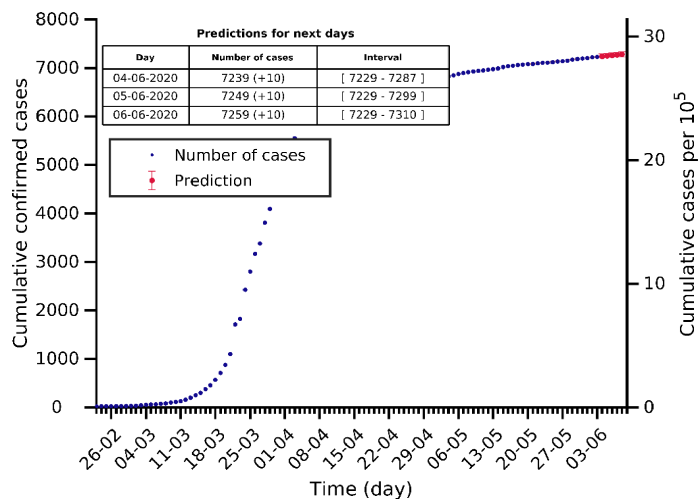
# South Korea 03-06-2020. Population: 51.3M. Current cumulated incidence: 23/10<sup>5</sup>



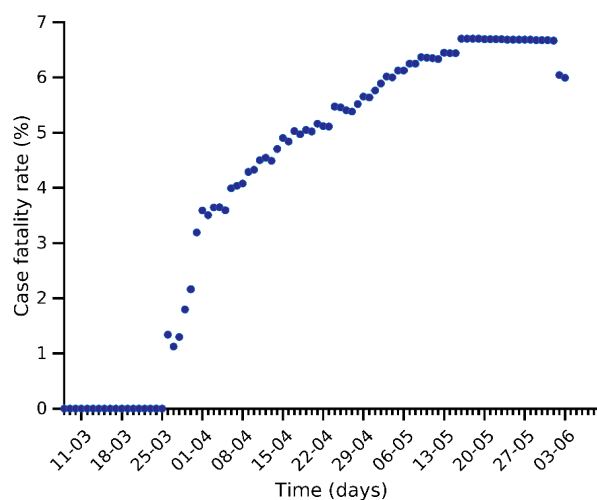
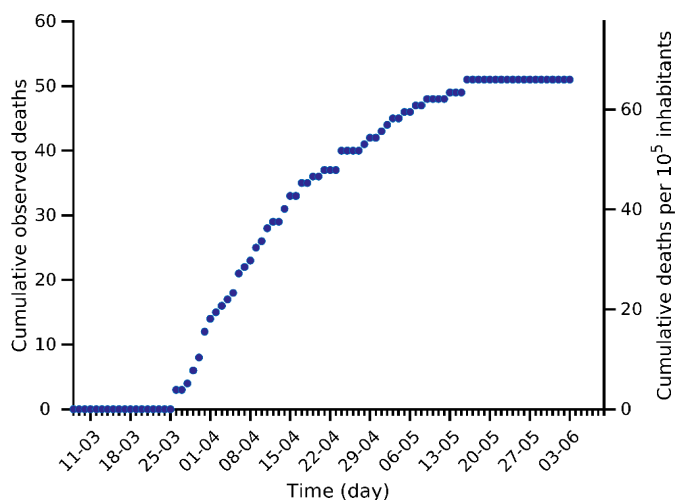
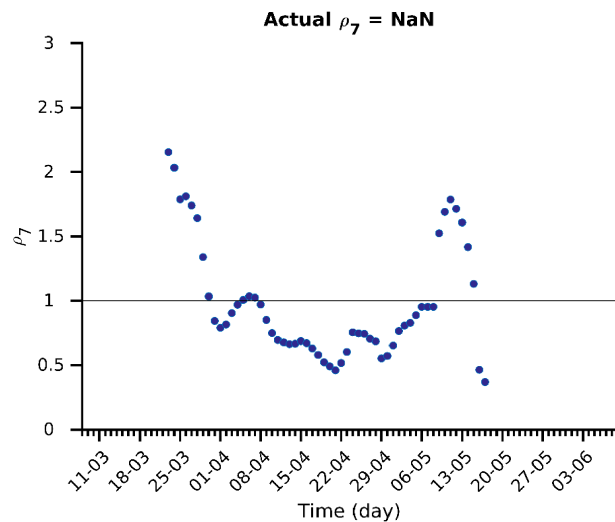
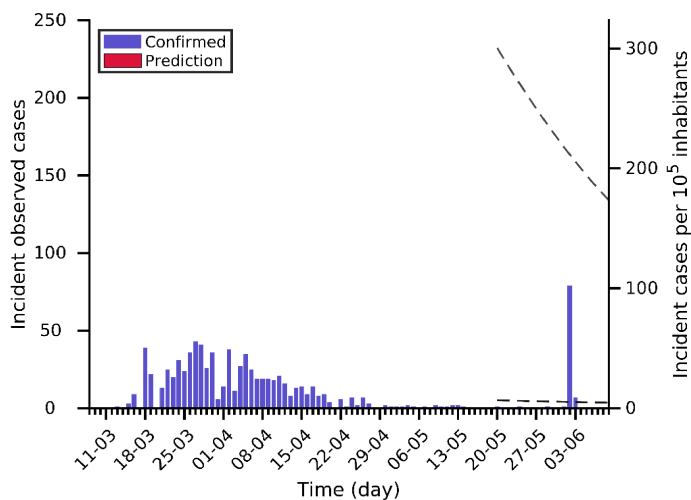
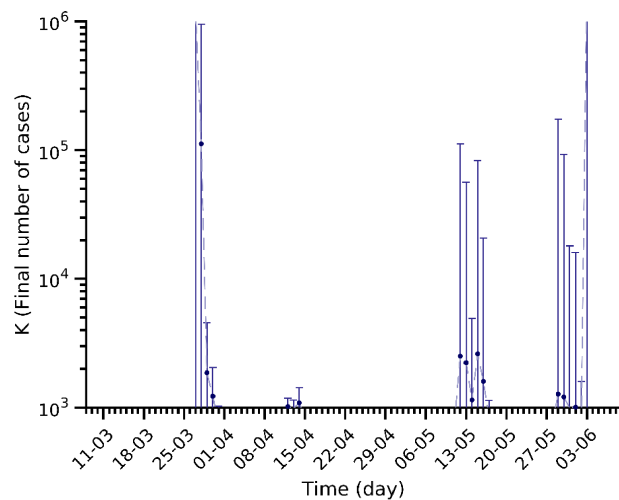
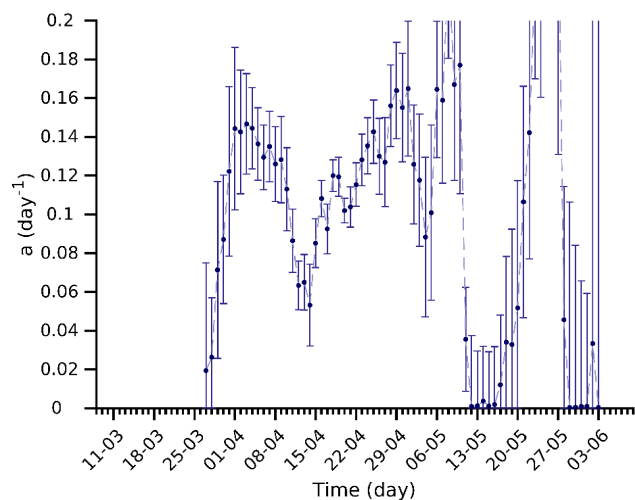
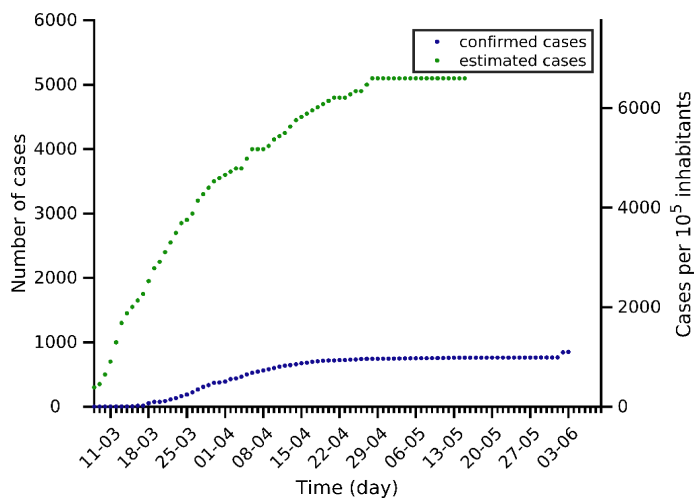
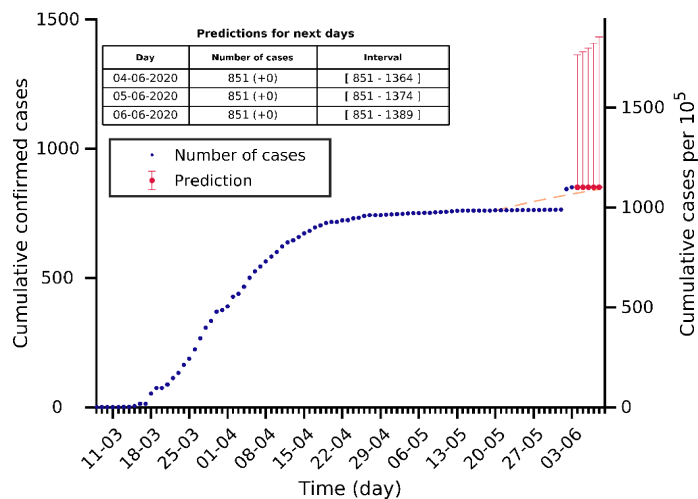
# Malaysia 03-06-2020. Population: 32.4M. Current cumulated incidence: 25/10<sup>5</sup>



# Australia 03-06-2020. Population: 25.5M. Current cumulated incidence: 28/10<sup>5</sup>



# Andorra 03-06-2020. Population: 0.1M. Current cumulated incidence: 1101/10<sup>5</sup>

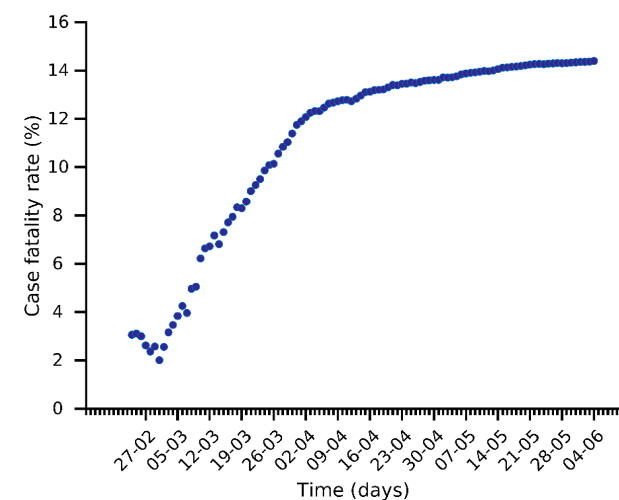
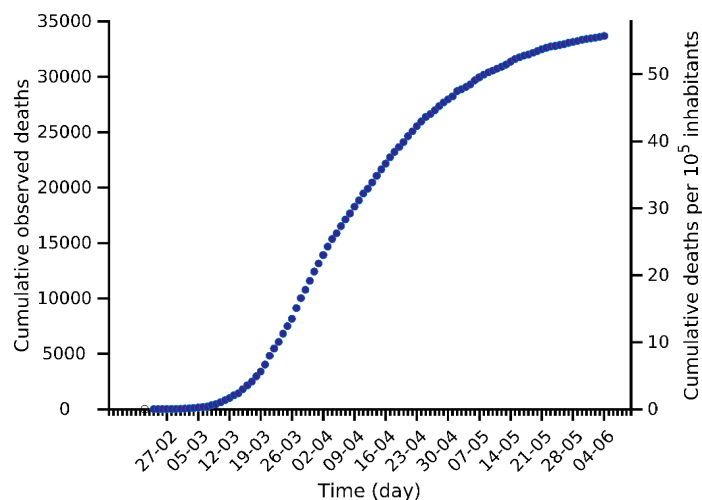
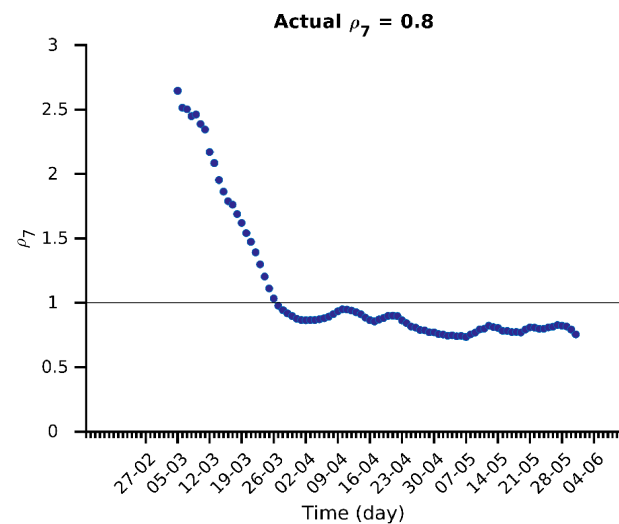
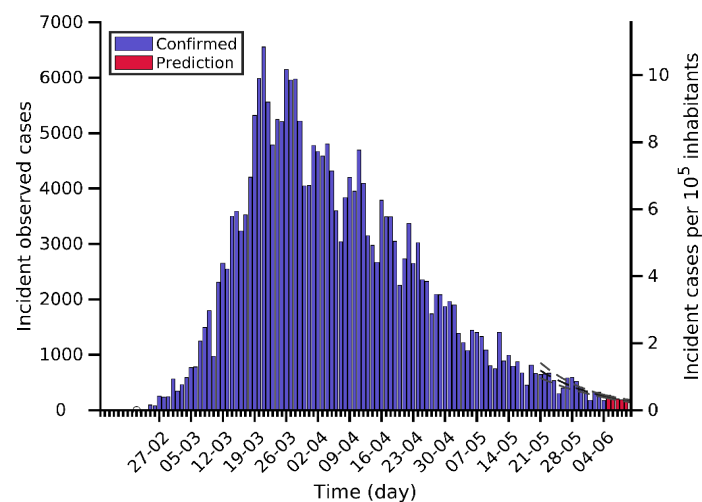
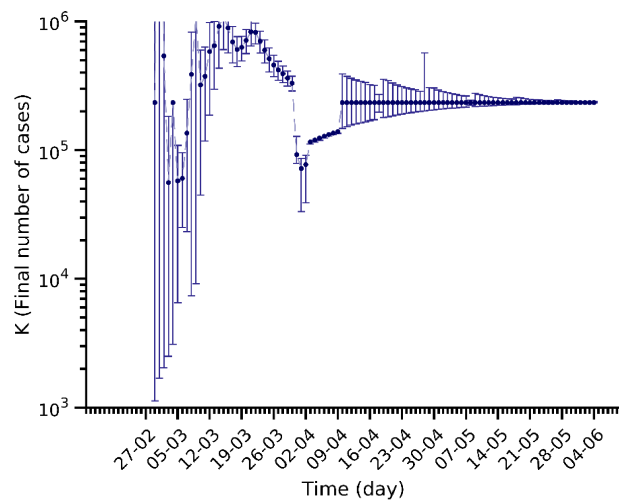
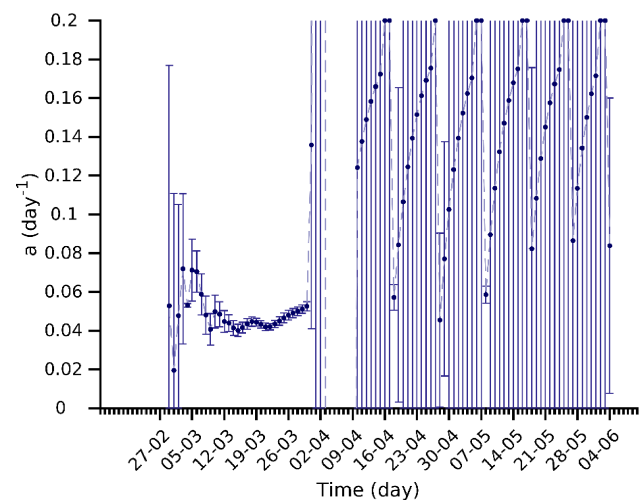
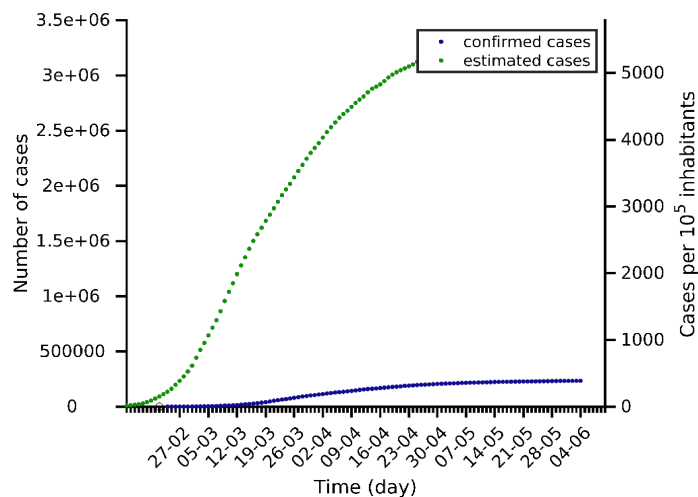
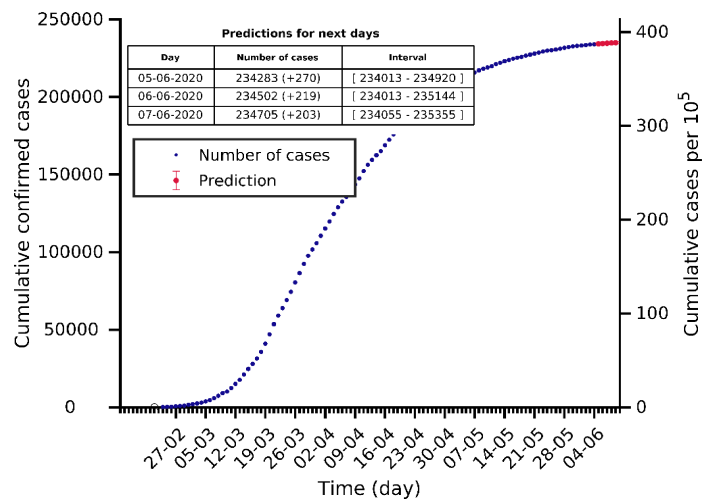




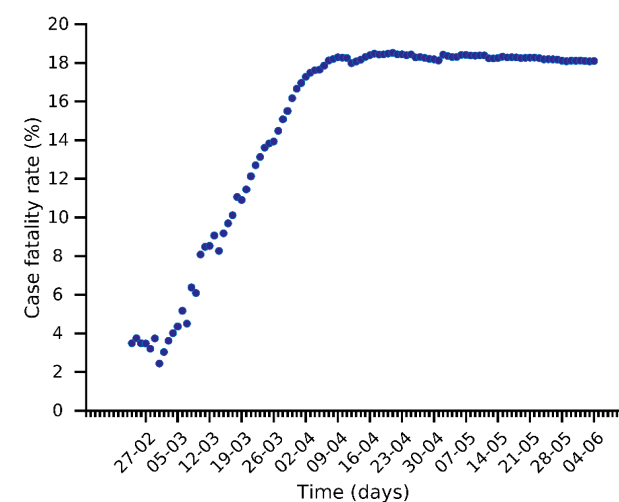
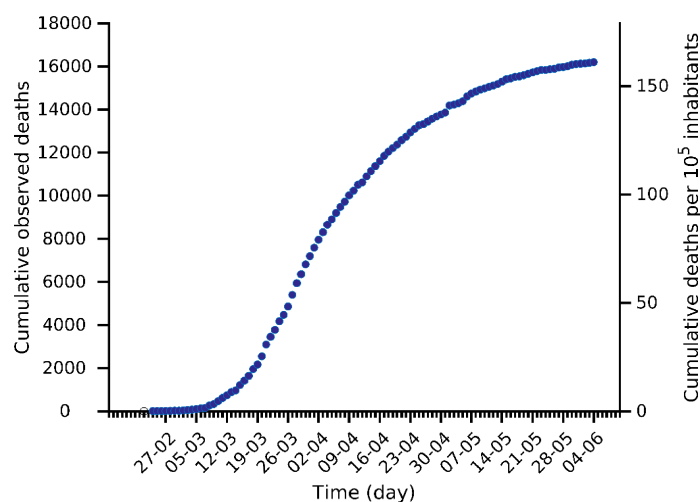
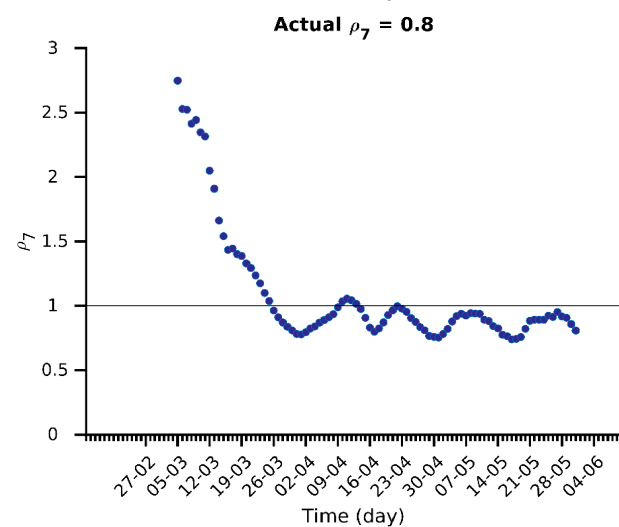
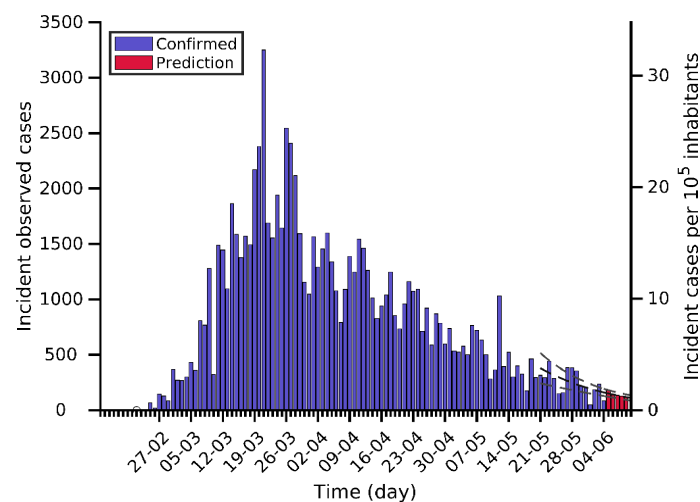
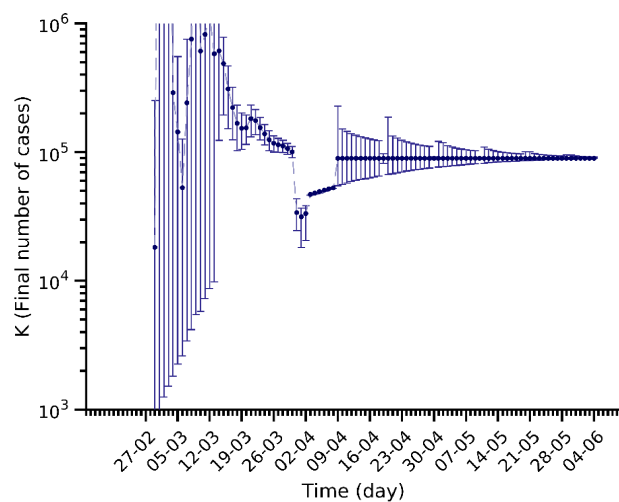
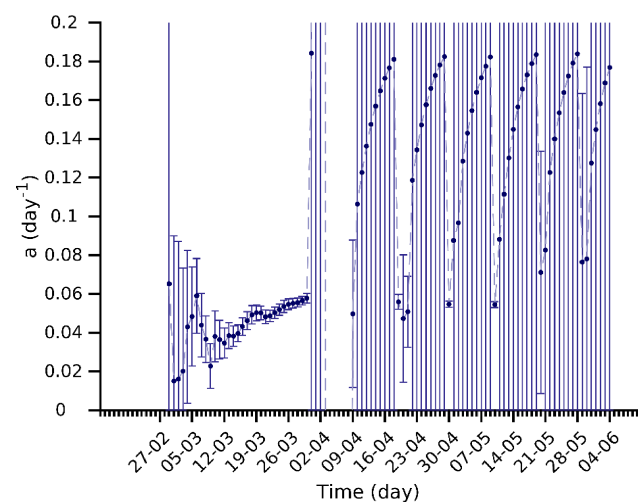
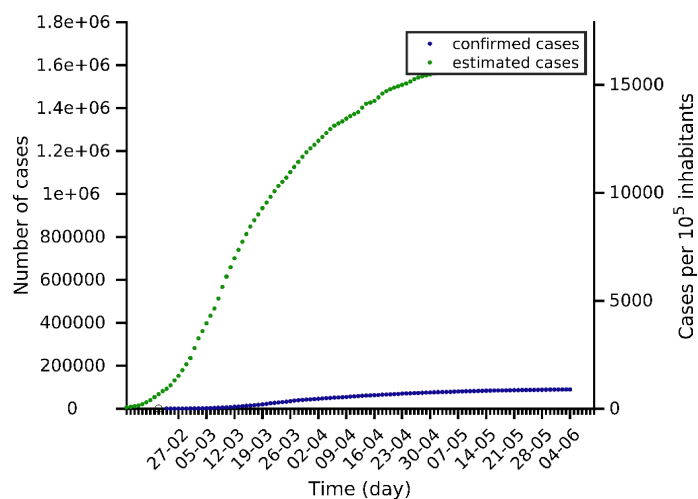
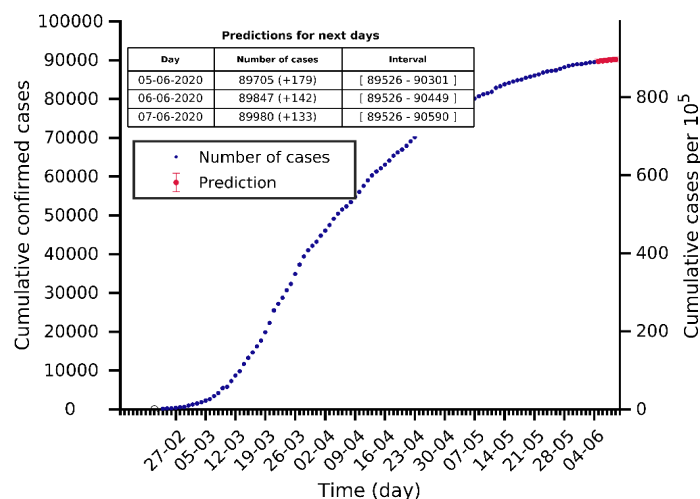
### **(3) Analysis and prediction of COVID-19 for Italy and its regions**

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

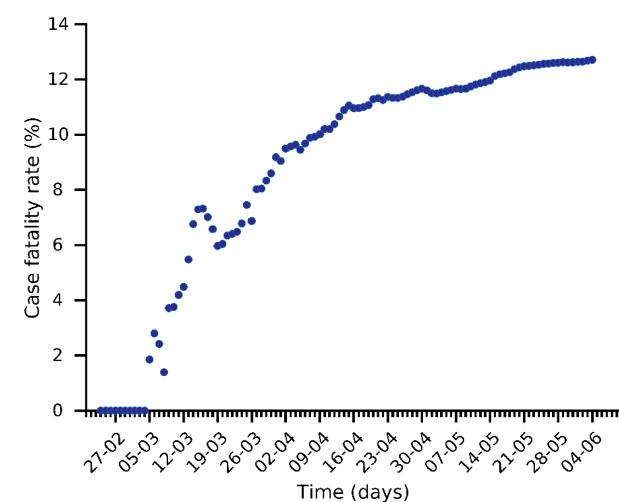
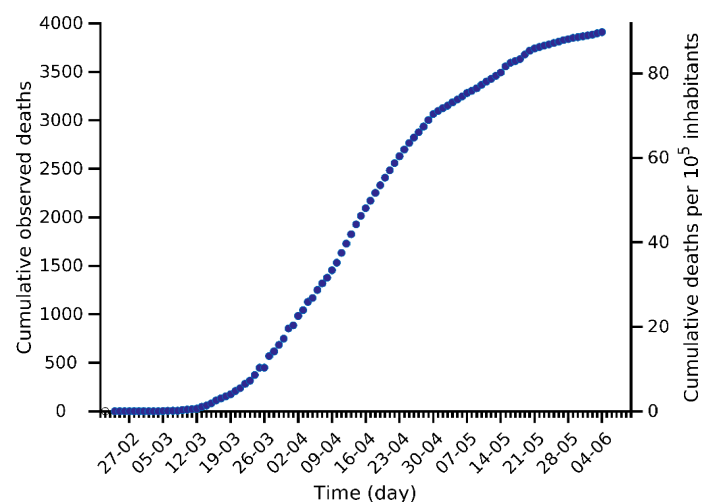
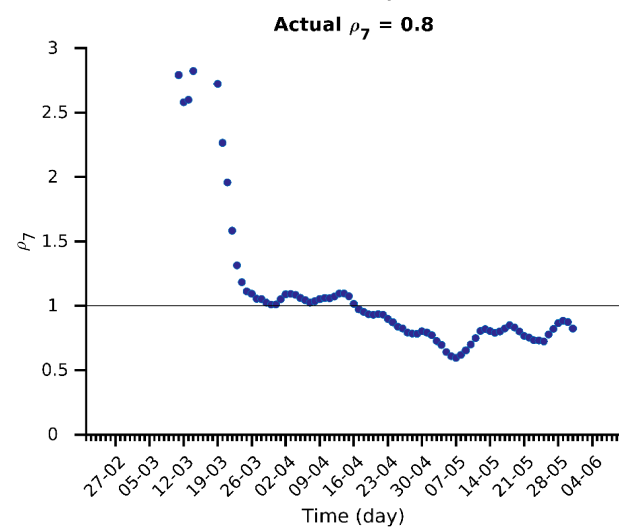
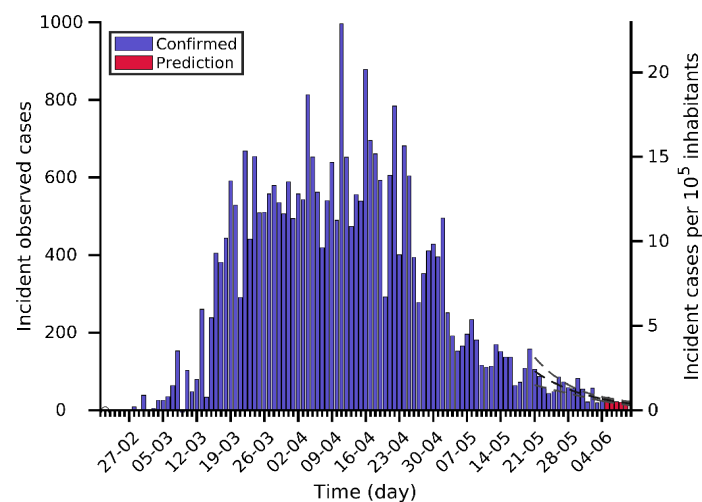
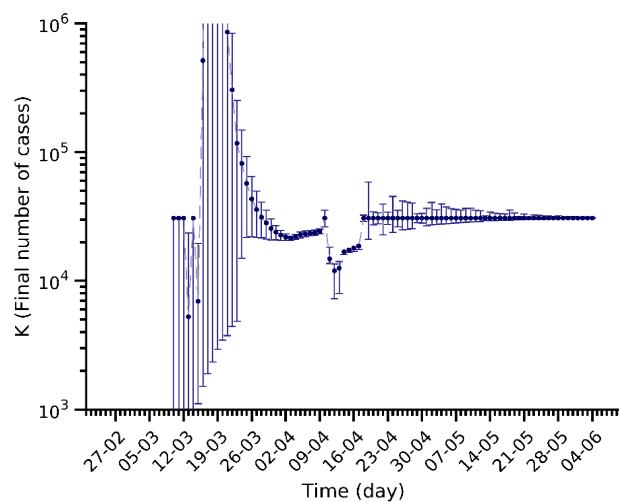
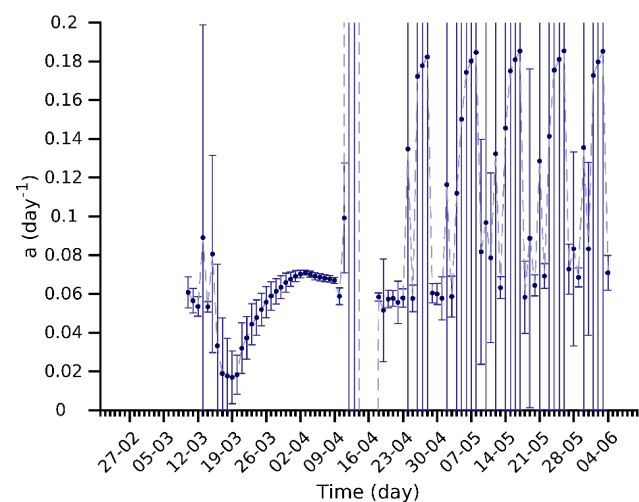
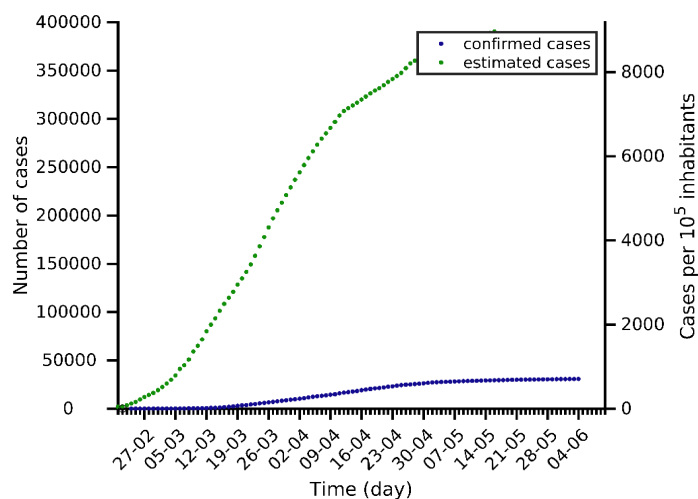
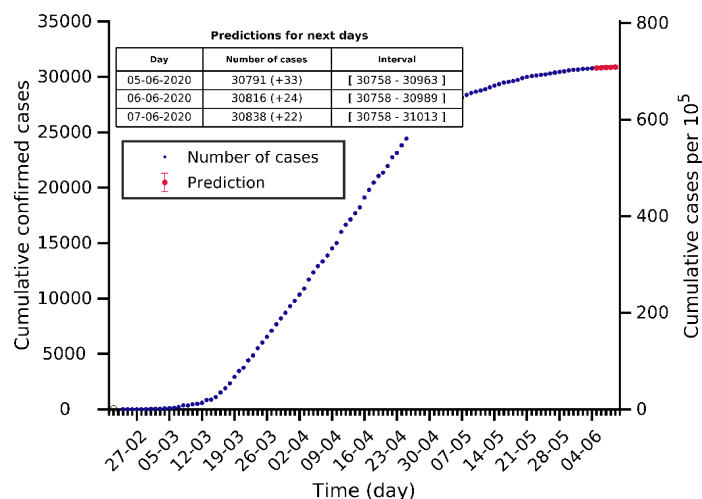
# Italy 04-06-2020. Population: 60.5M. Current cumulated incidence: 387/10<sup>5</sup>



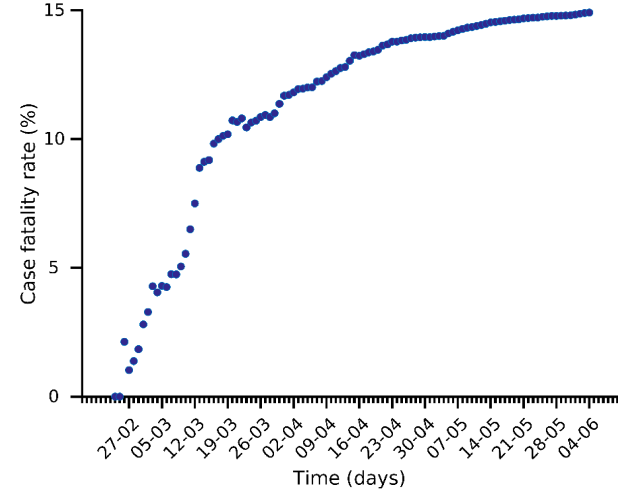
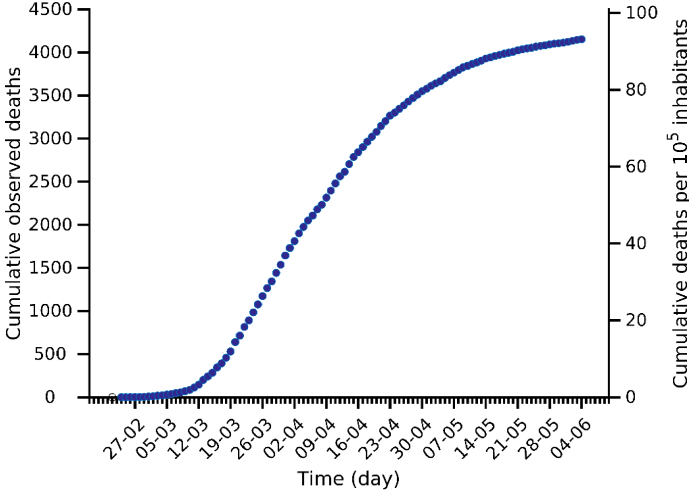
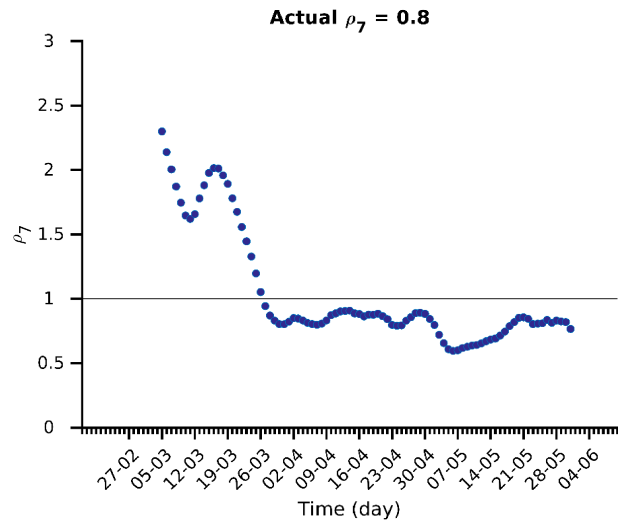
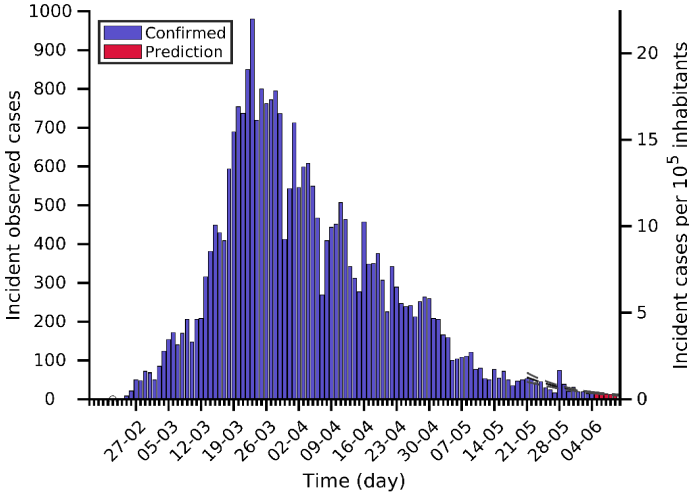
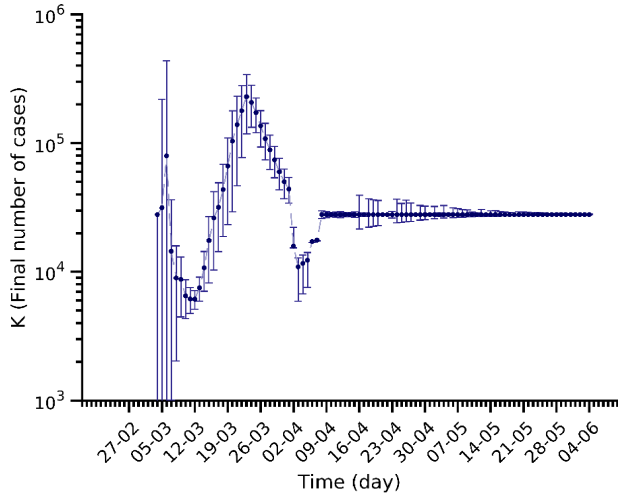
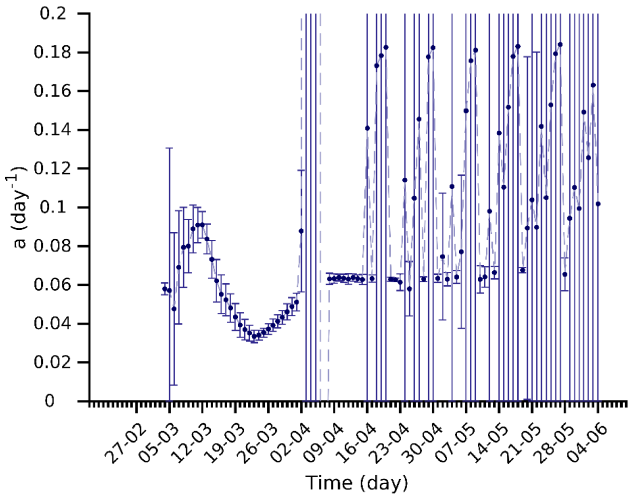
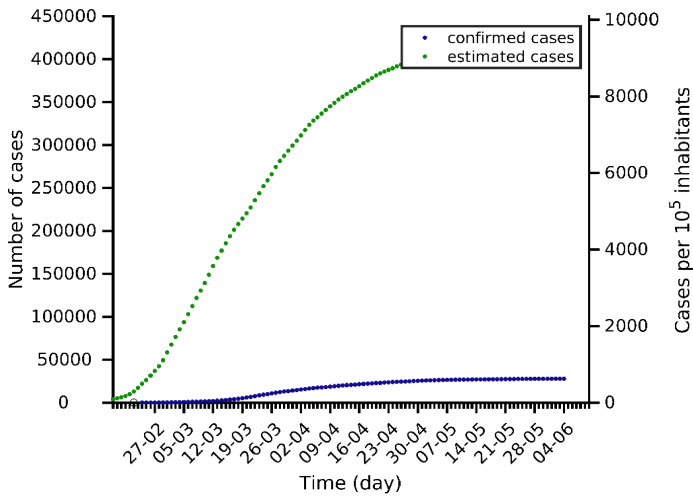
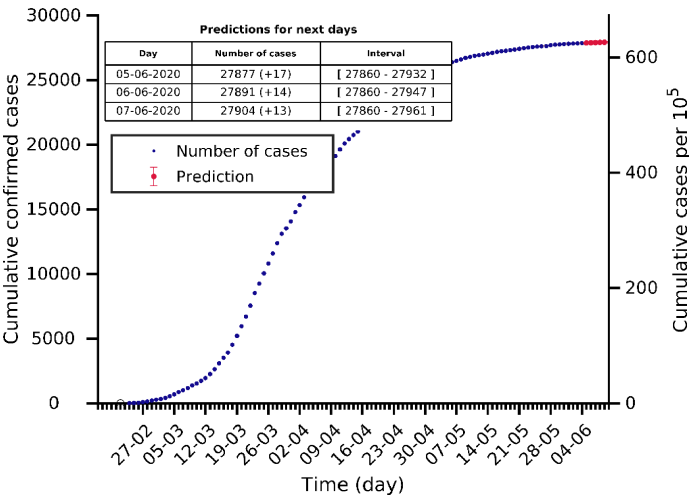
# Lombardia 04-06-2020. Population: 10.1M. Current cumulated incidence: 890/10<sup>5</sup>



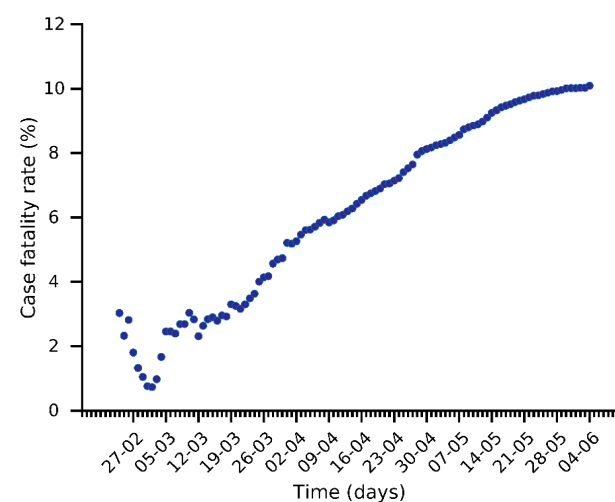
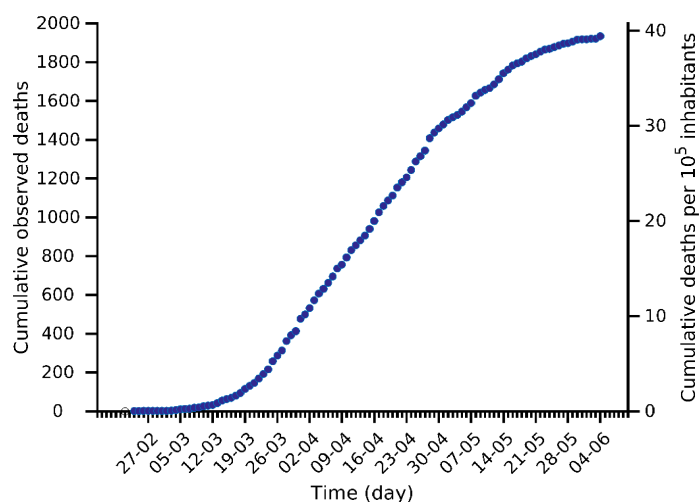
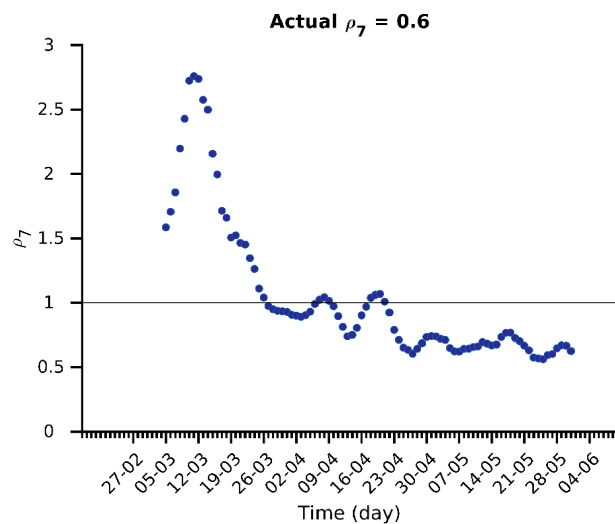
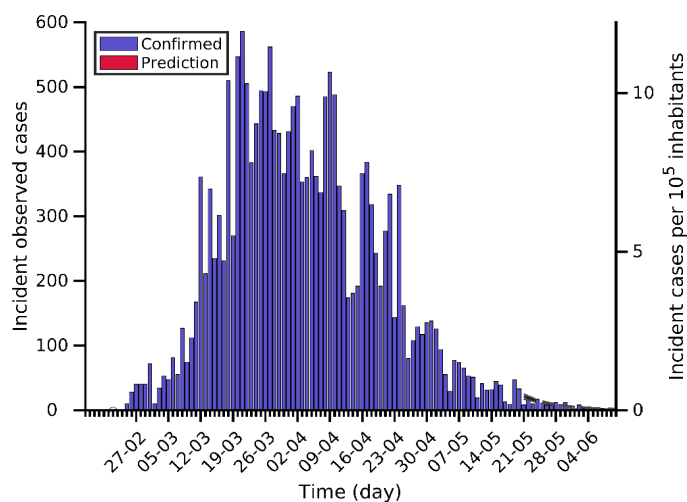
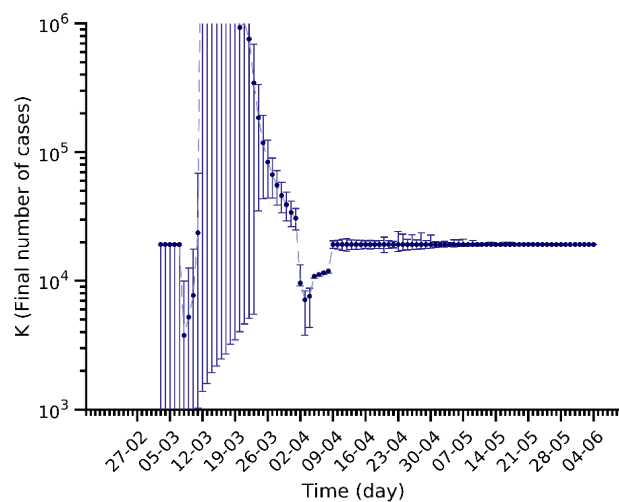
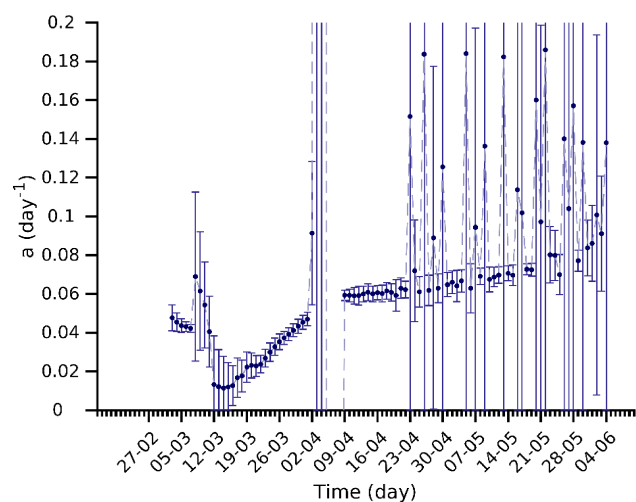
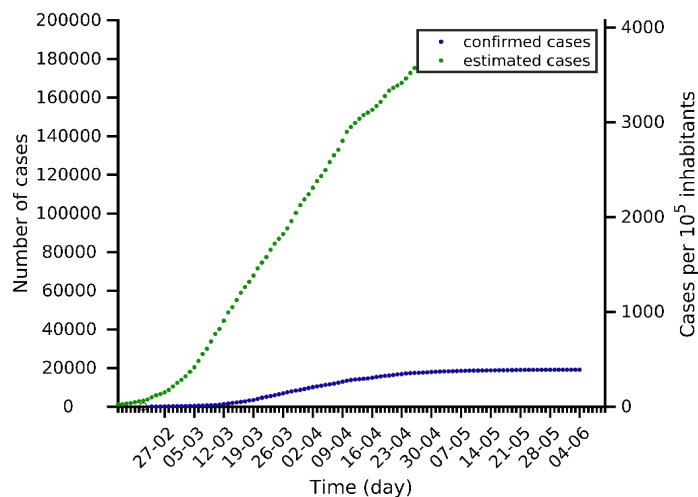
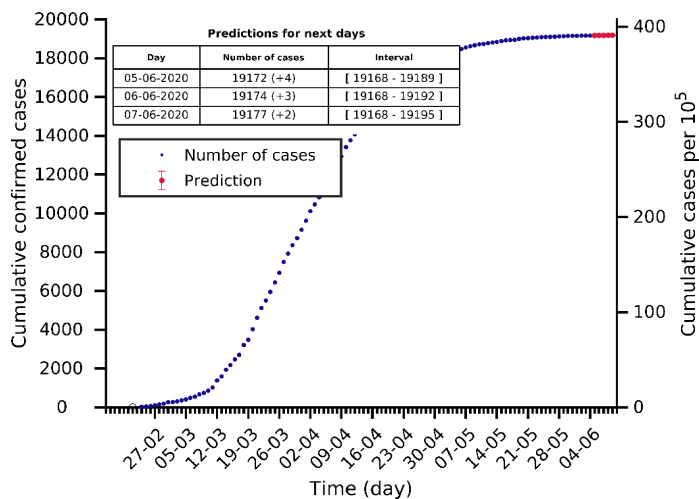
# Piemonte 04-06-2020. Population: 4.4M. Current cumulated incidence: 706/10<sup>5</sup>



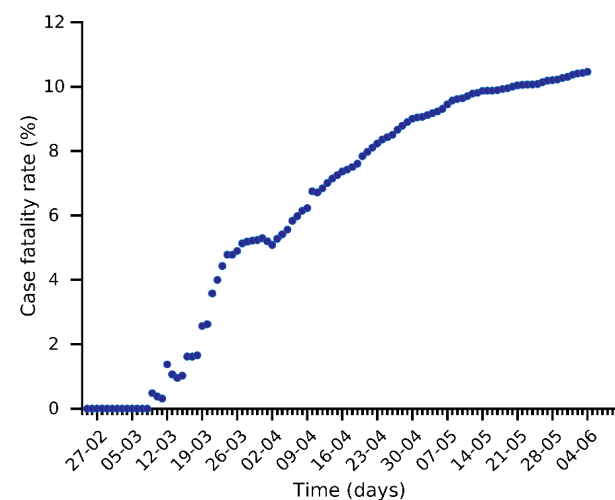
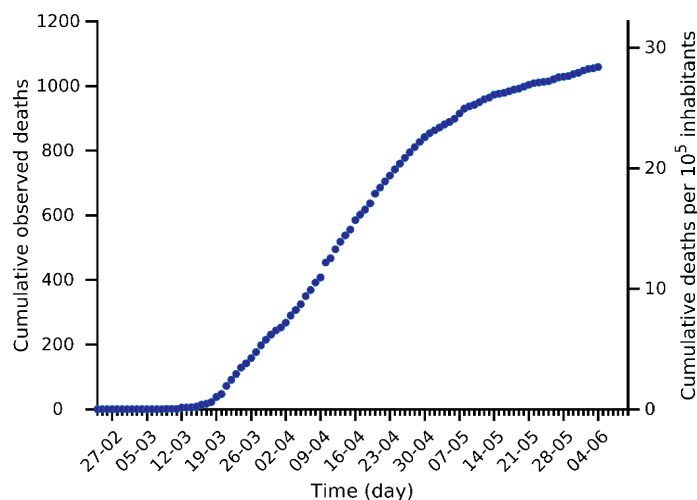
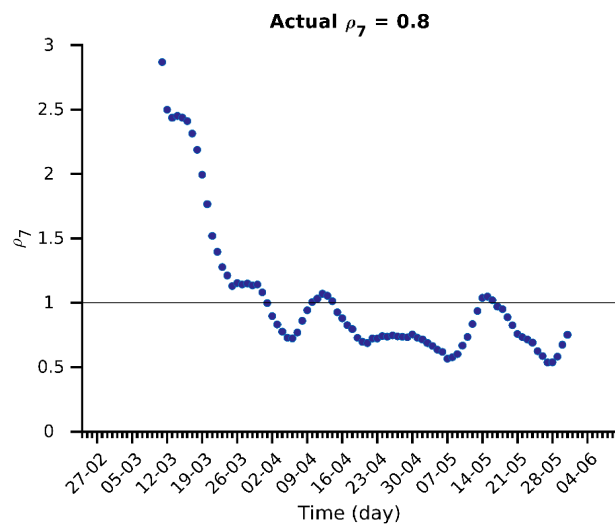
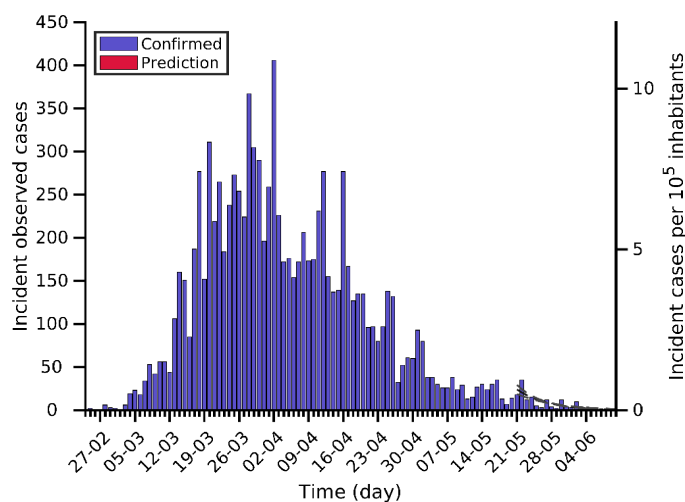
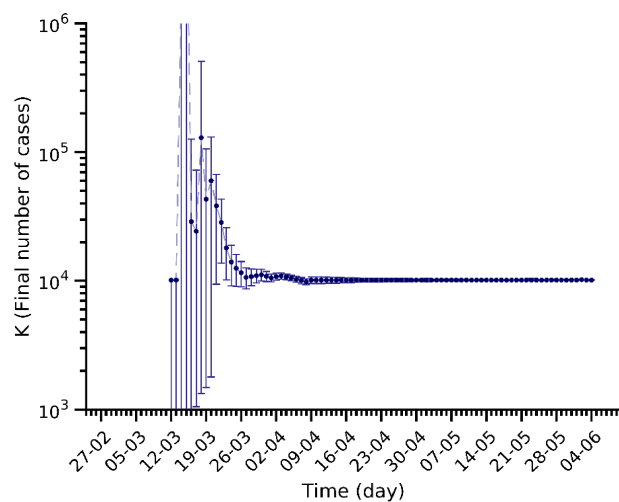
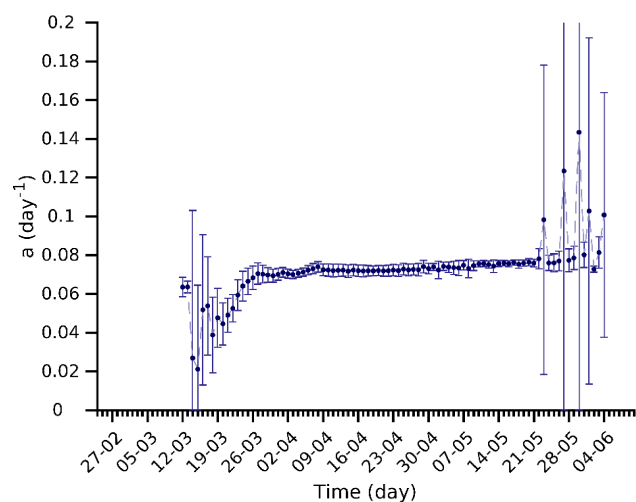
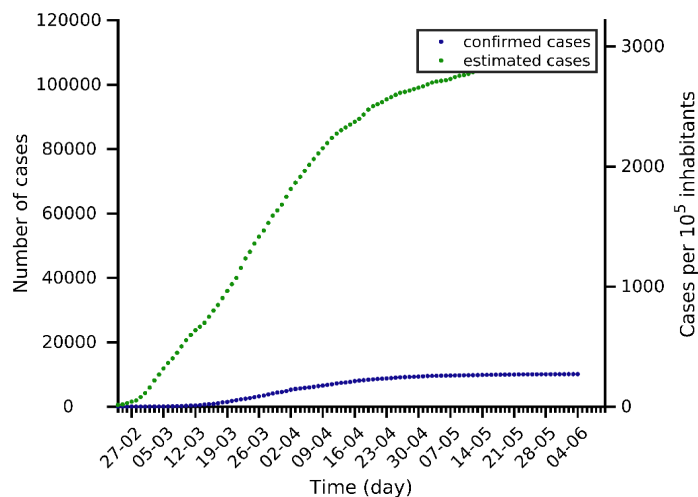
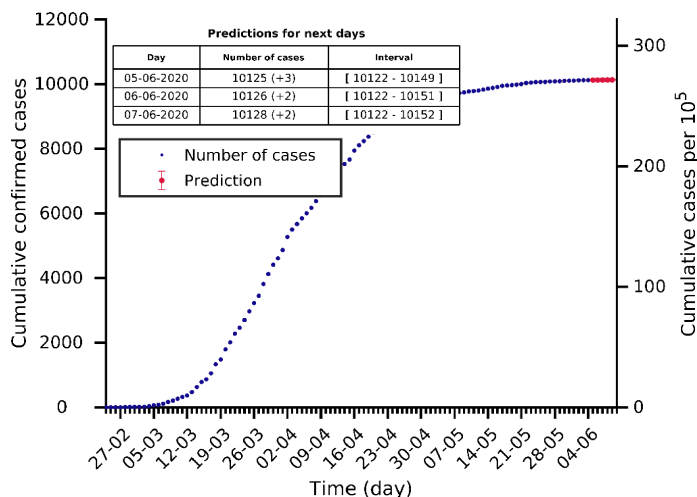
Emilia Romagna 04-06-2020. Population: 4.5M. Current cumulated incidence: 625/100000



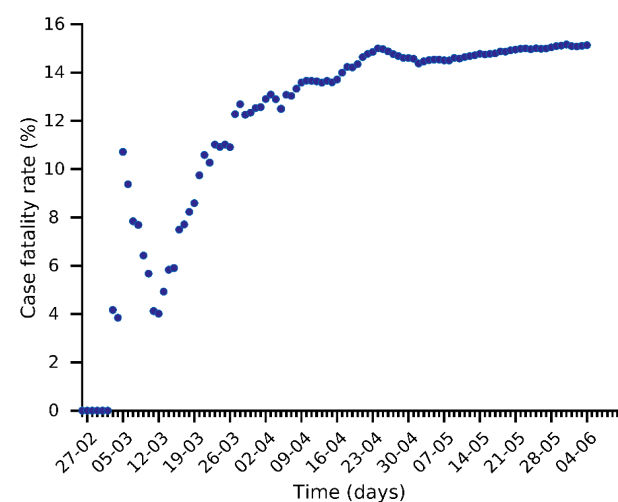
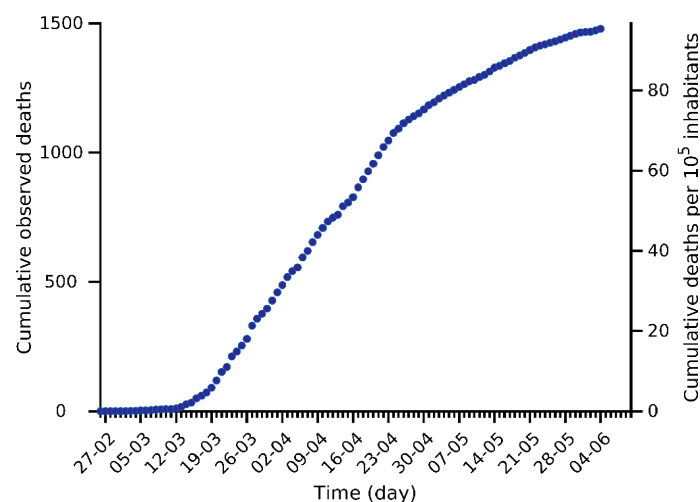
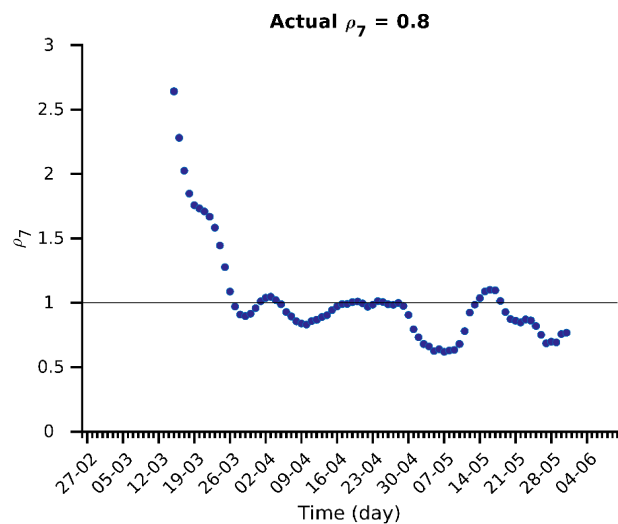
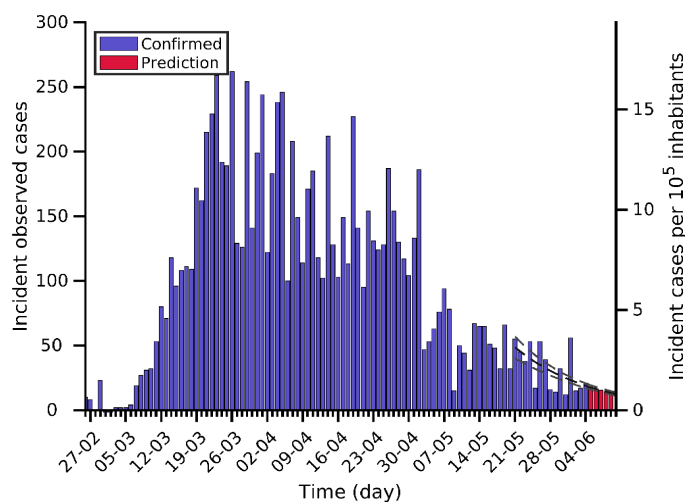
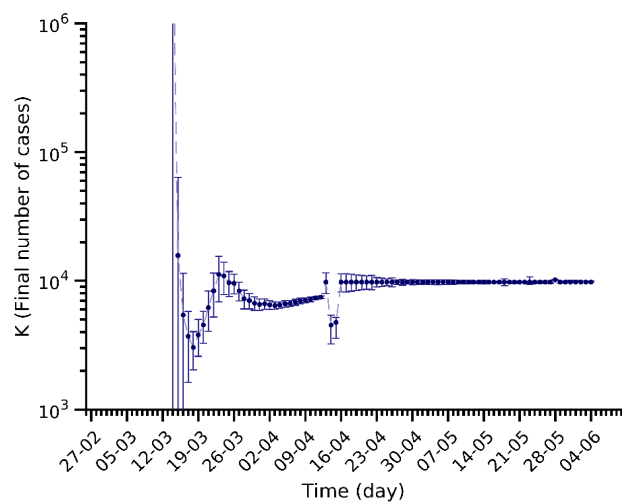
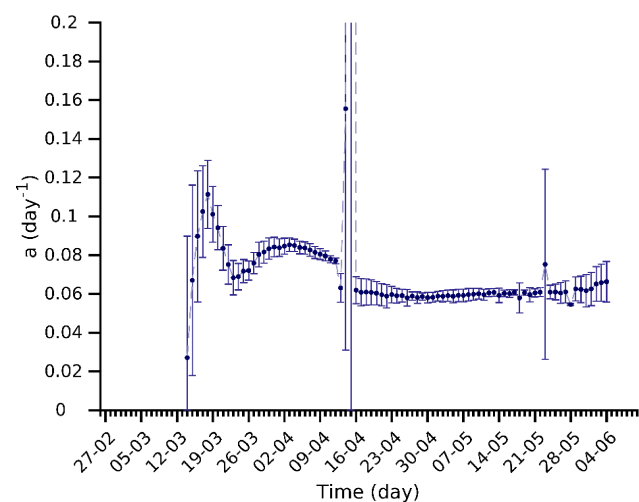
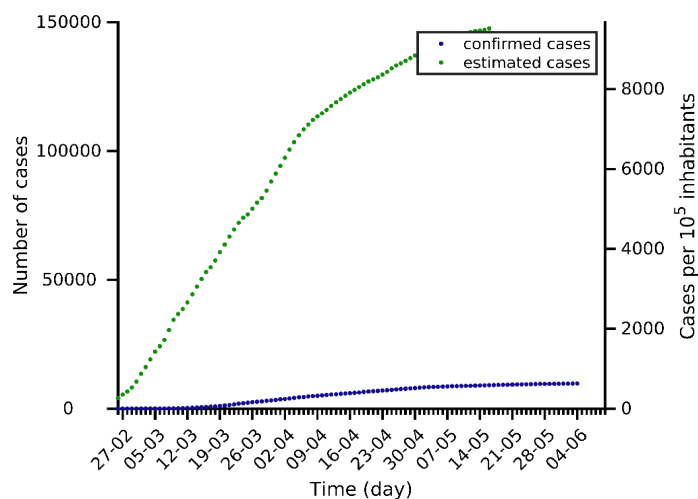
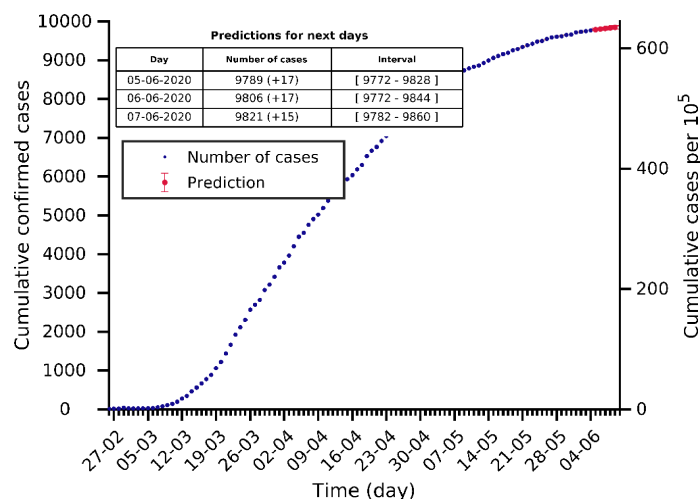
# Veneto 04-06-2020. Population: 4.9M. Current cumulated incidence: 391/10<sup>5</sup>



# Toscana 04-06-2020. Population: 3.7M. Current cumulated incidence: 271/10<sup>5</sup>

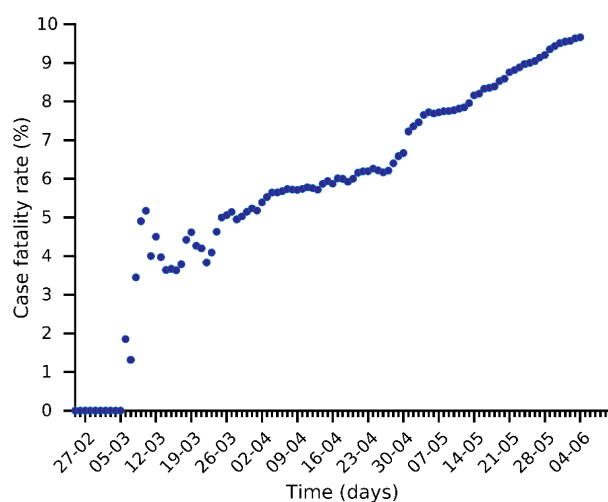
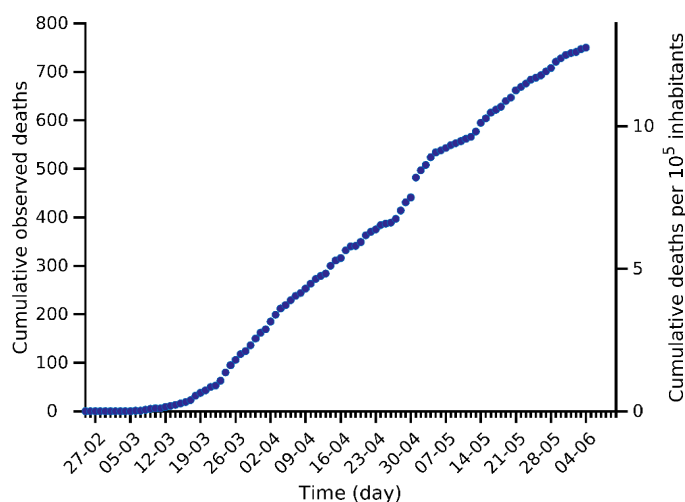
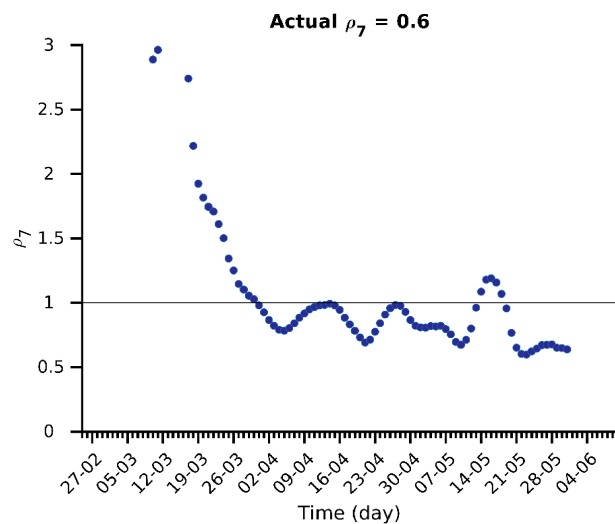
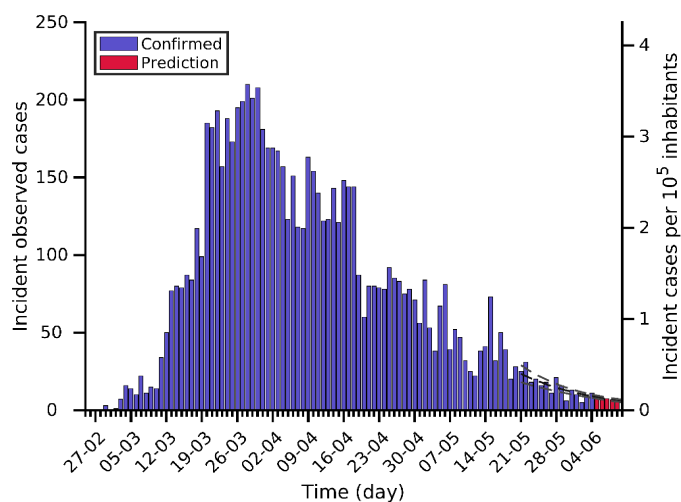
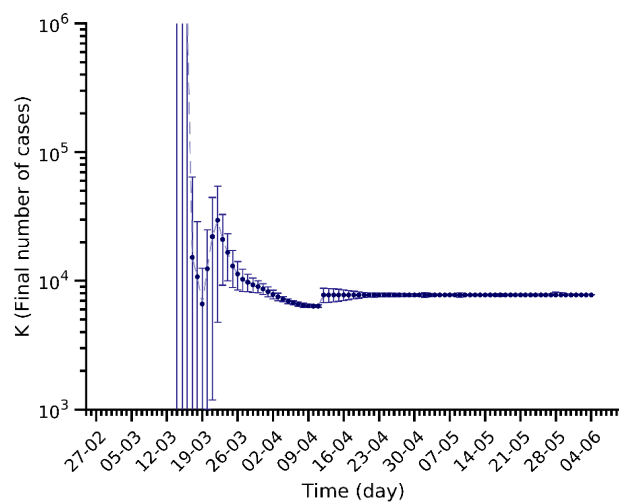
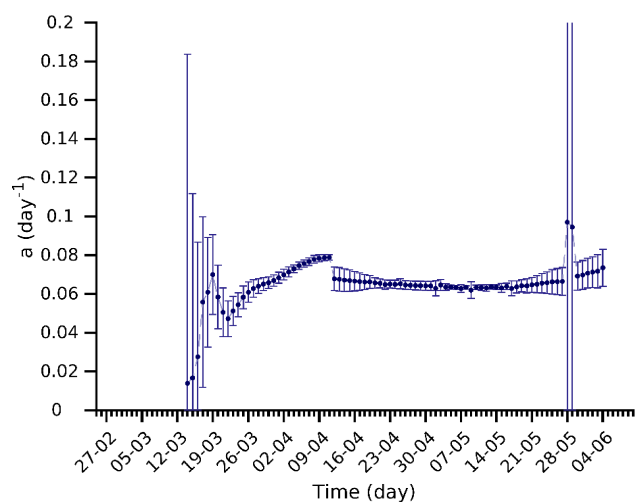
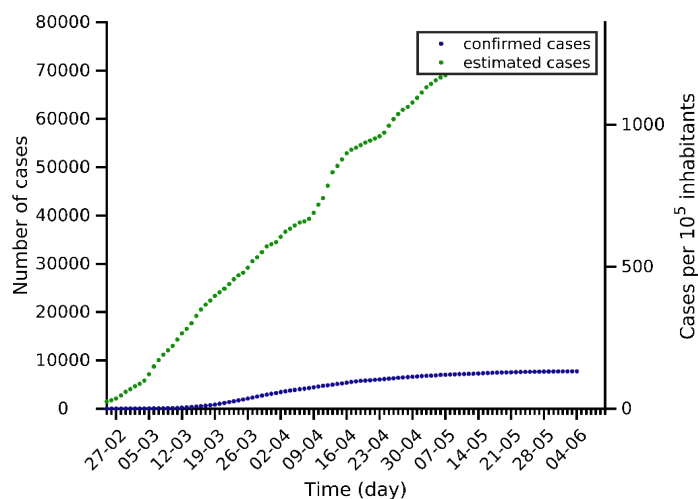
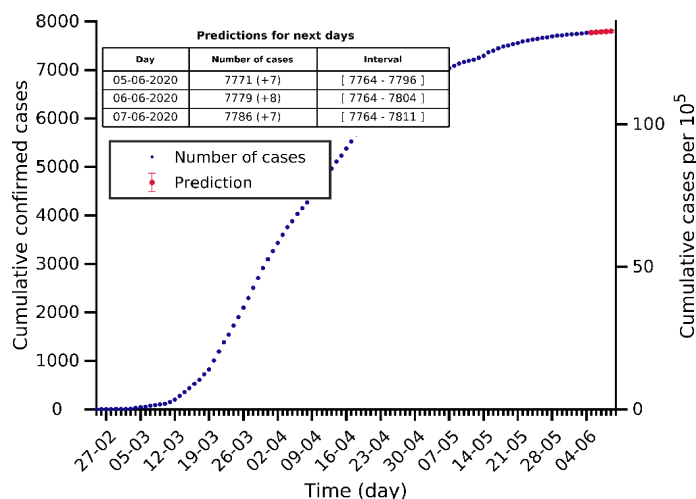


# Liguria 04-06-2020. Population: 1.6M. Current cumulated incidence: 630/10<sup>5</sup>

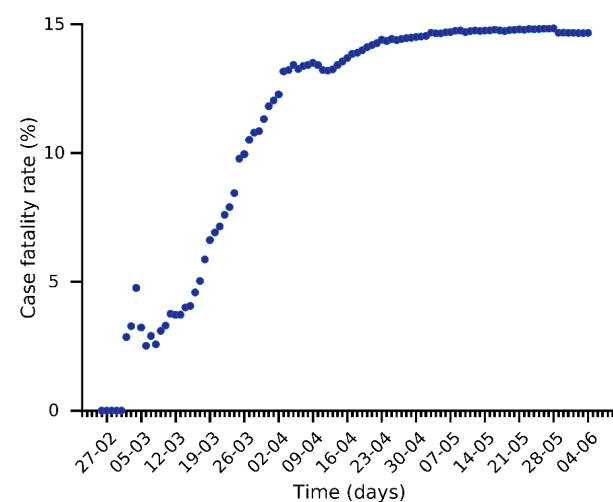
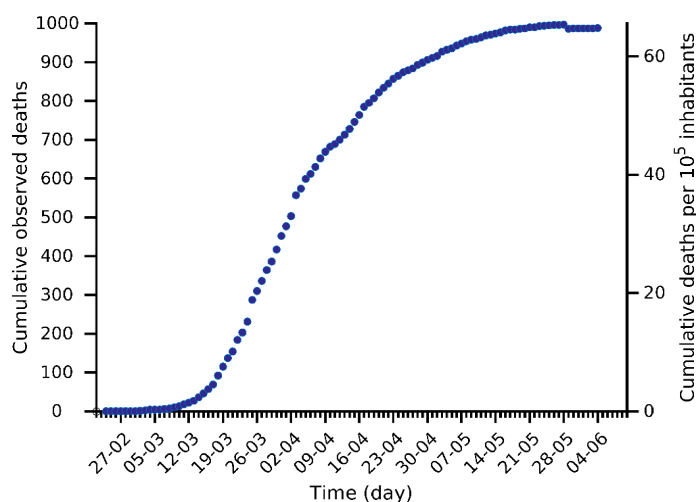
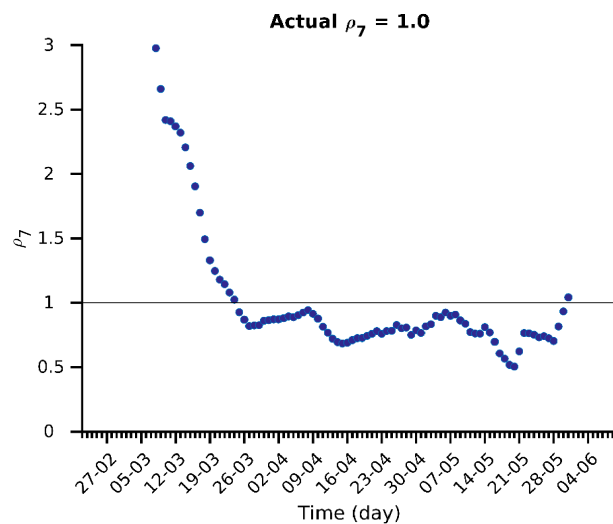
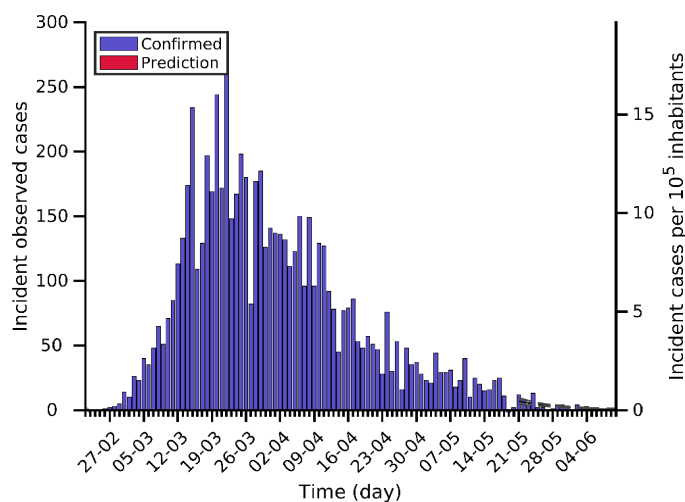
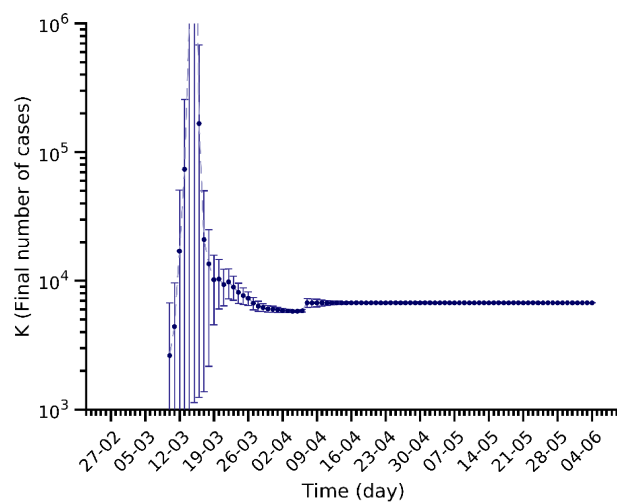
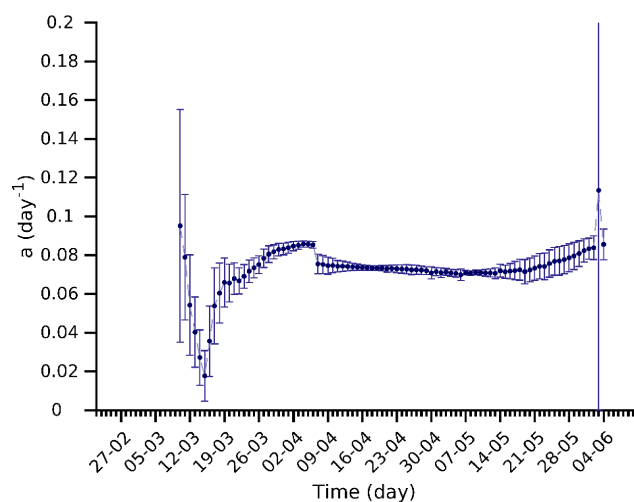
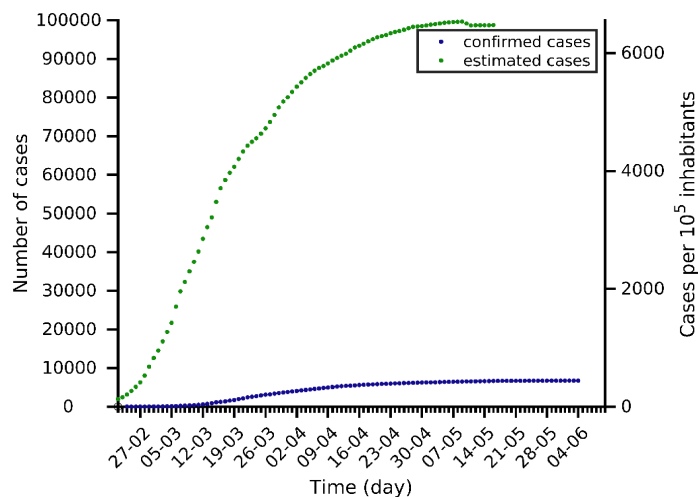
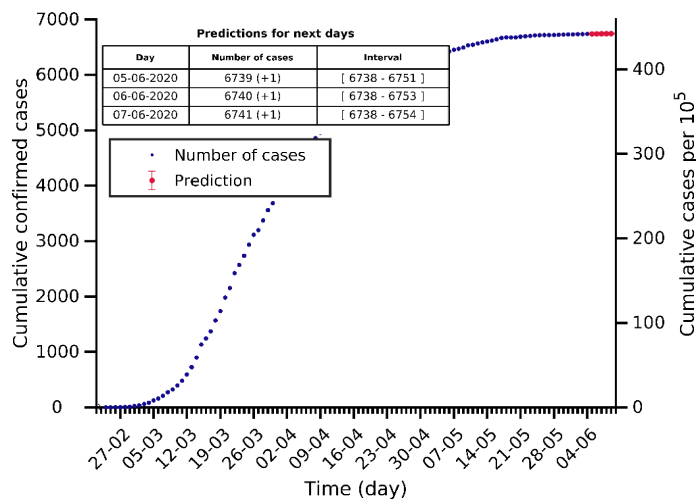




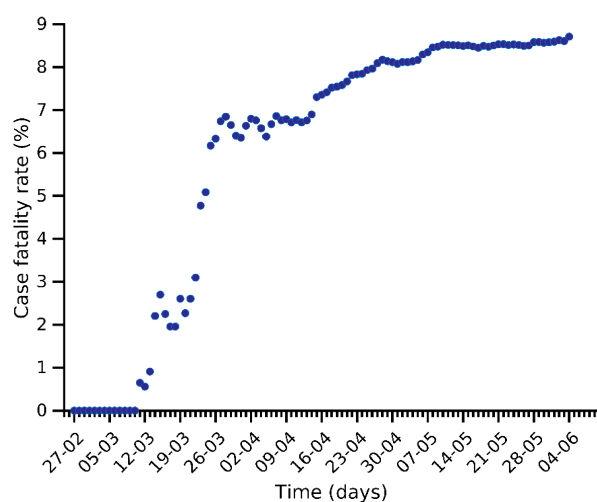
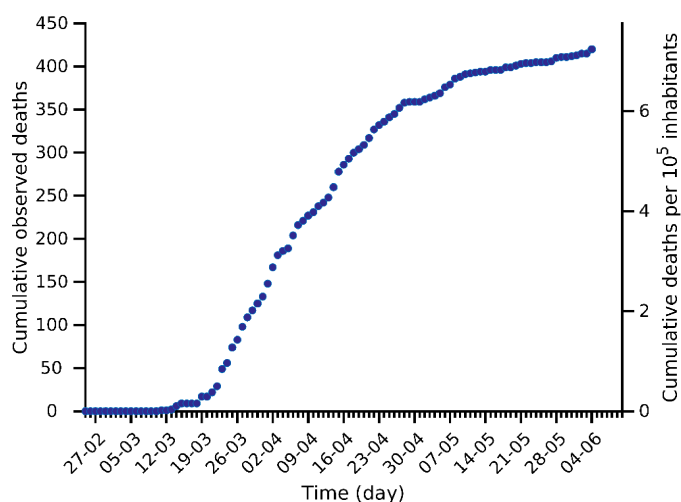
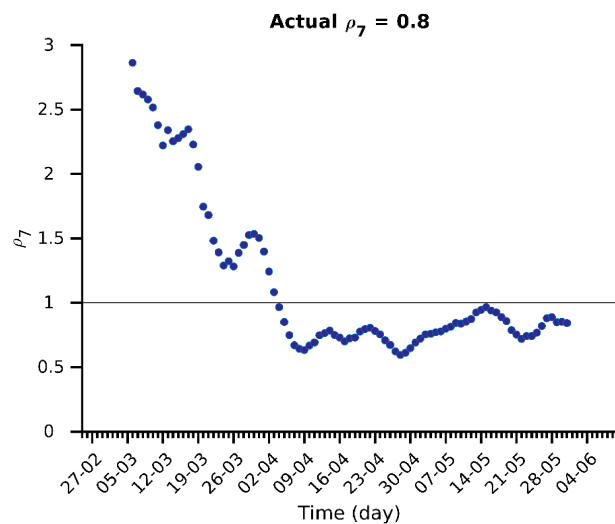
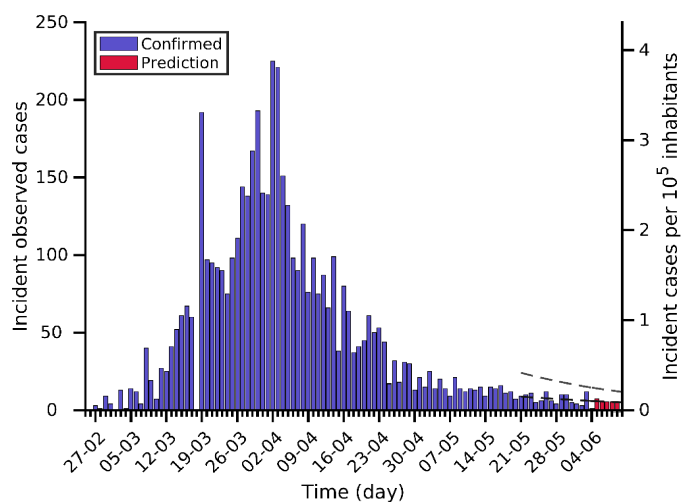
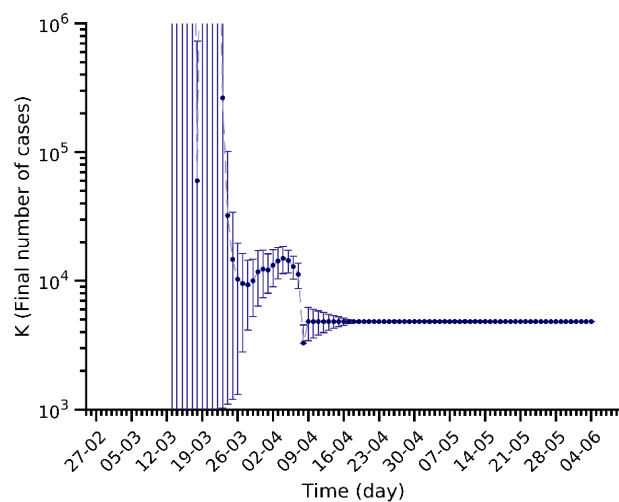
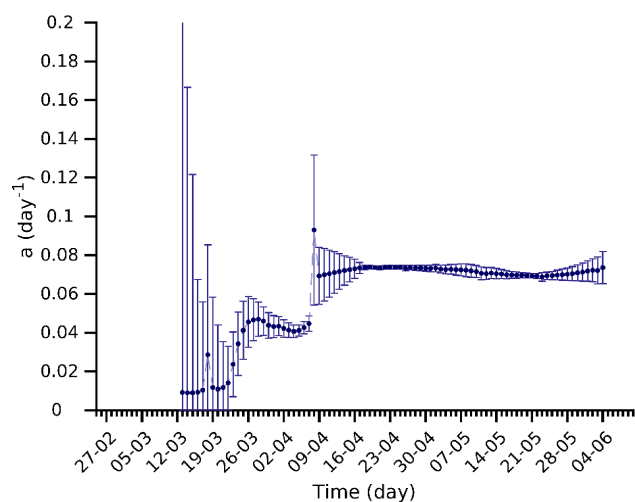
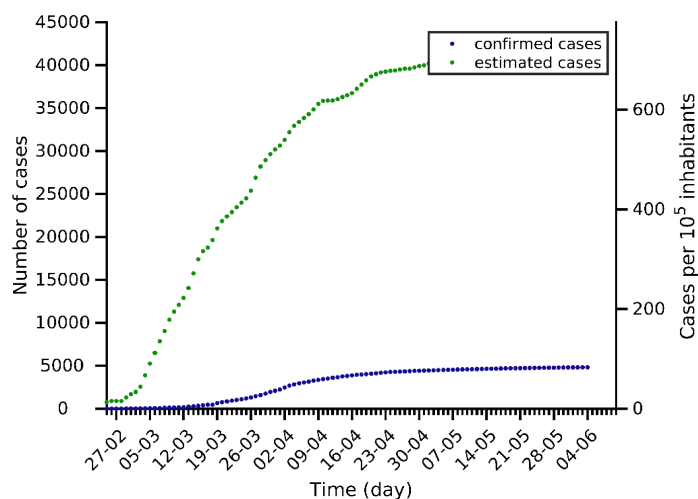
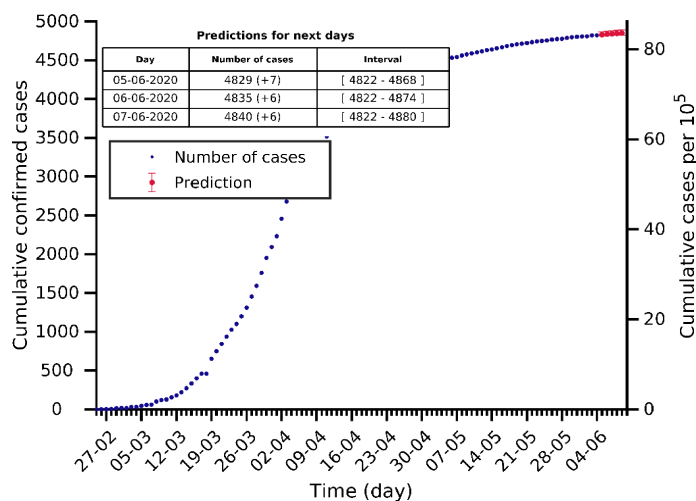
# Lazio 04-06-2020. Population: 5.9M. Current cumulated incidence: 132/10<sup>5</sup>



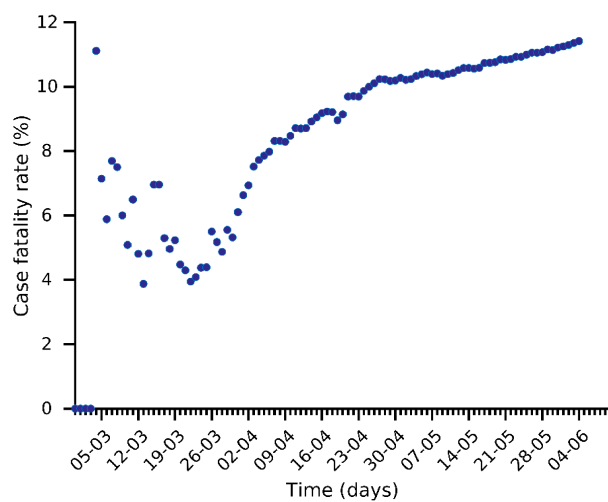
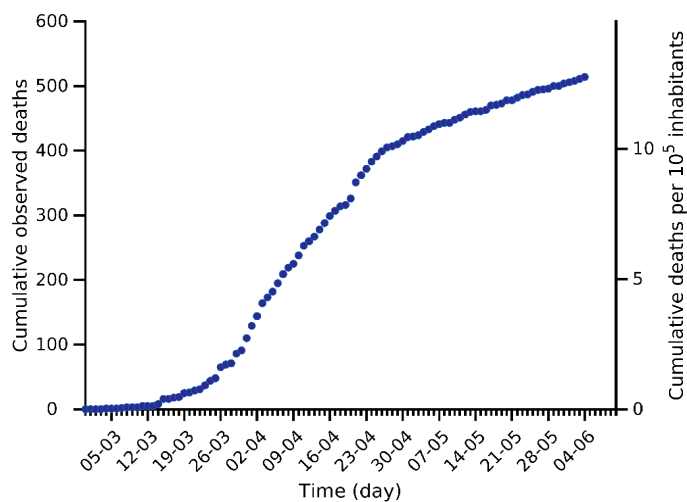
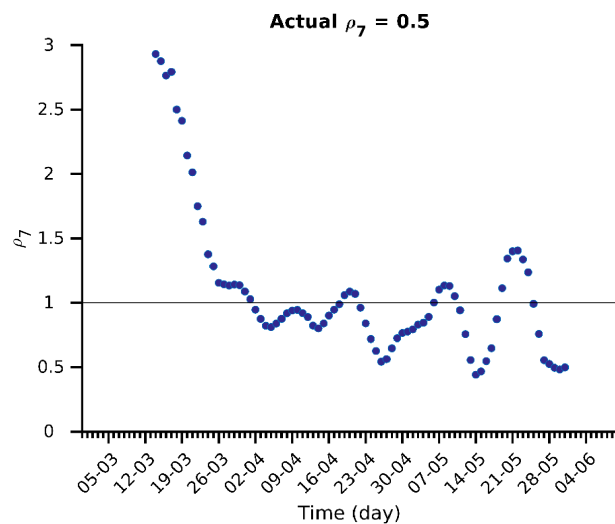
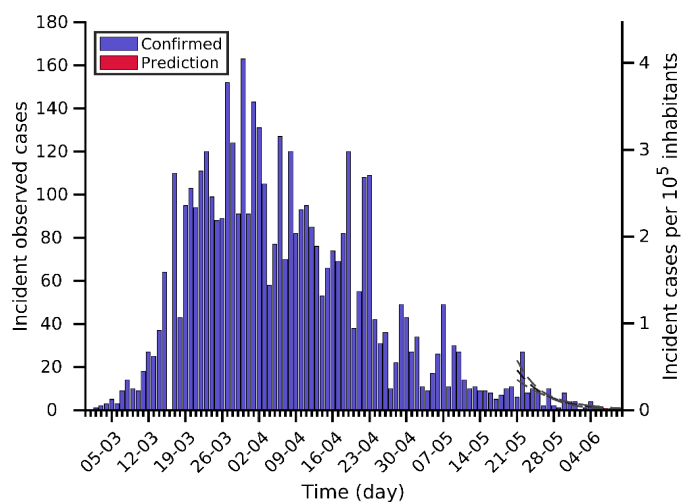
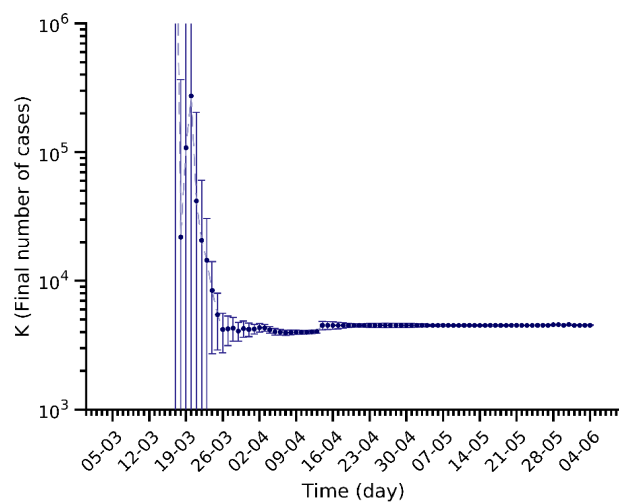
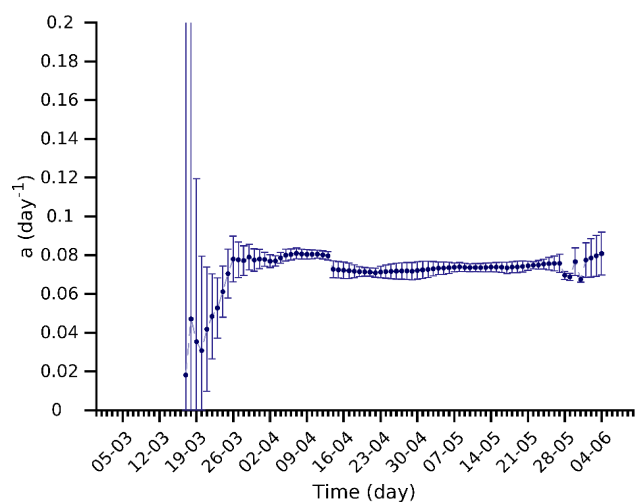
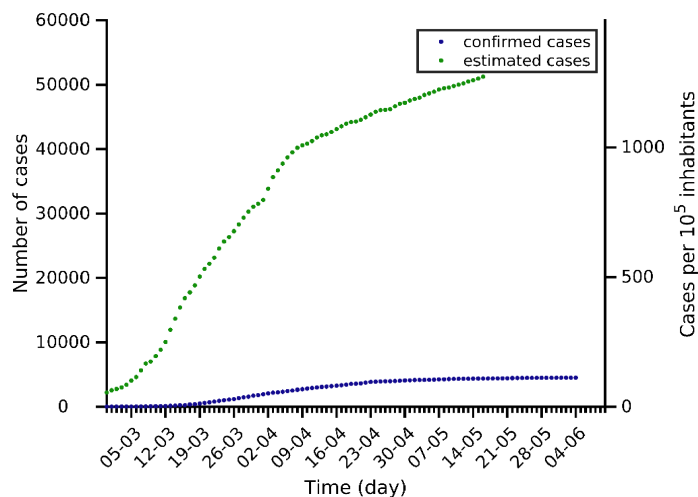
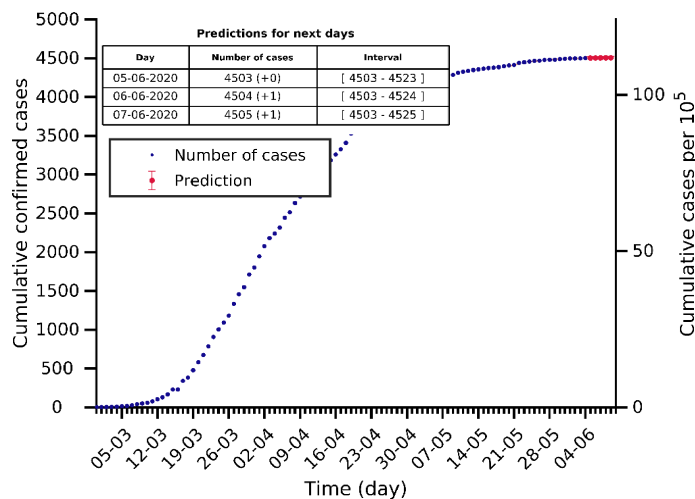
# **Marche 04-06-2020. Population: 1.5M. Current cumulated incidence: 442/10<sup>5</sup>**



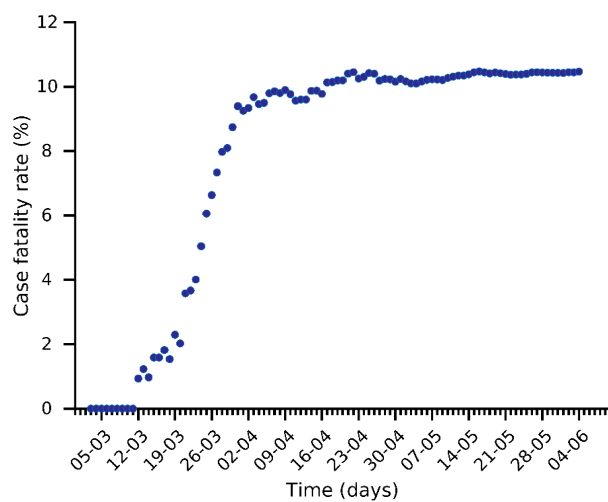
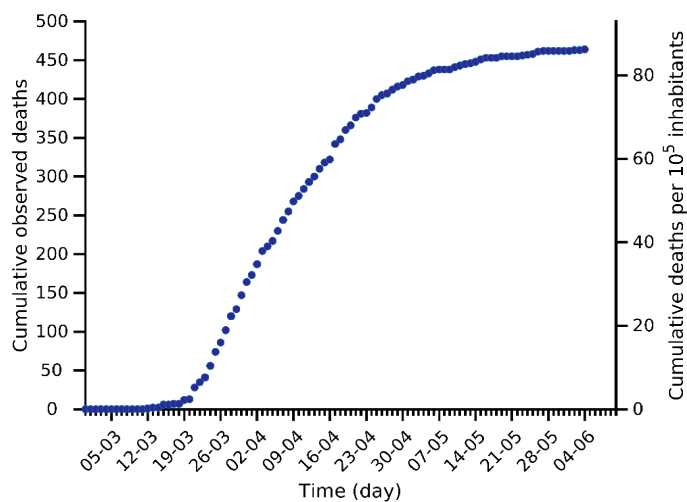
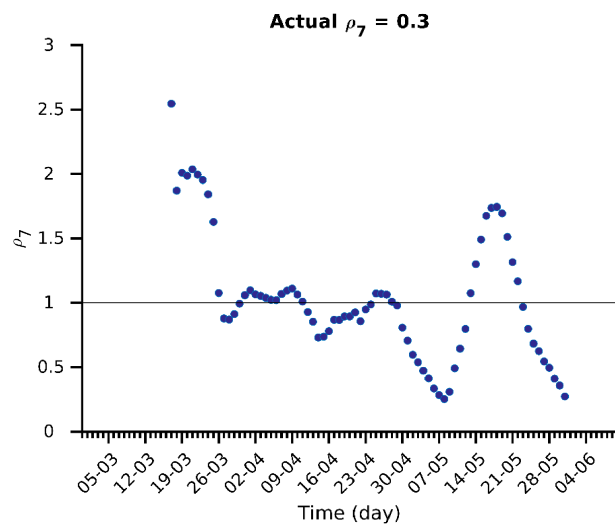
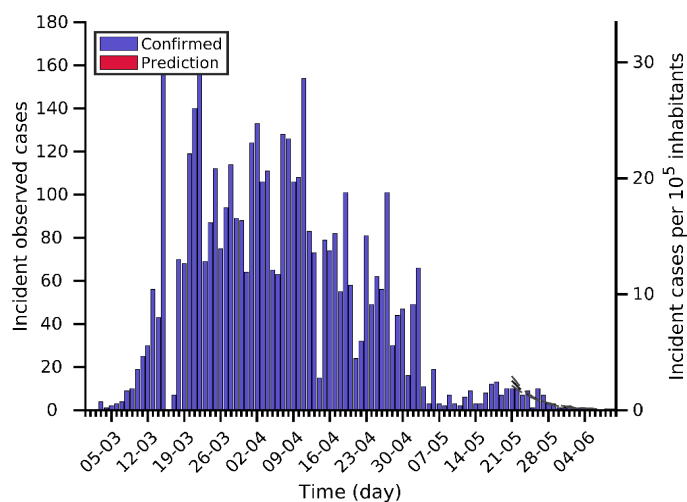
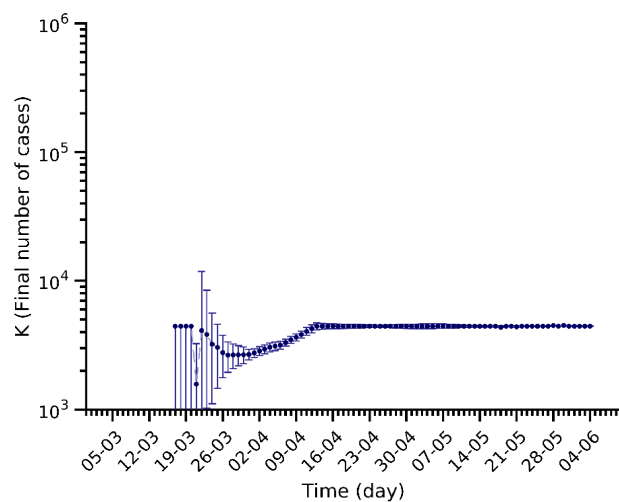
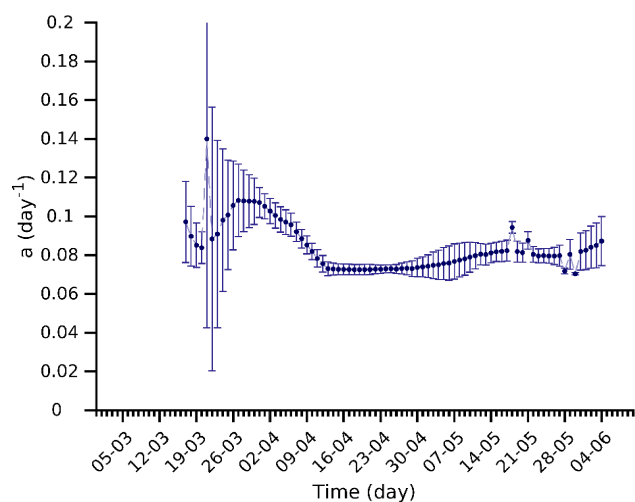
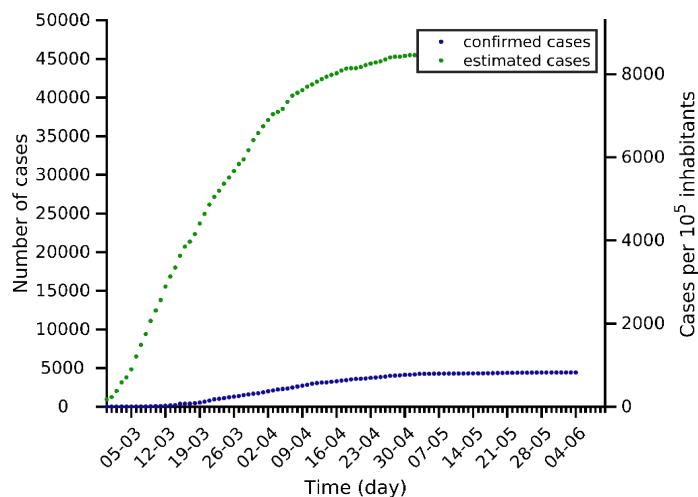
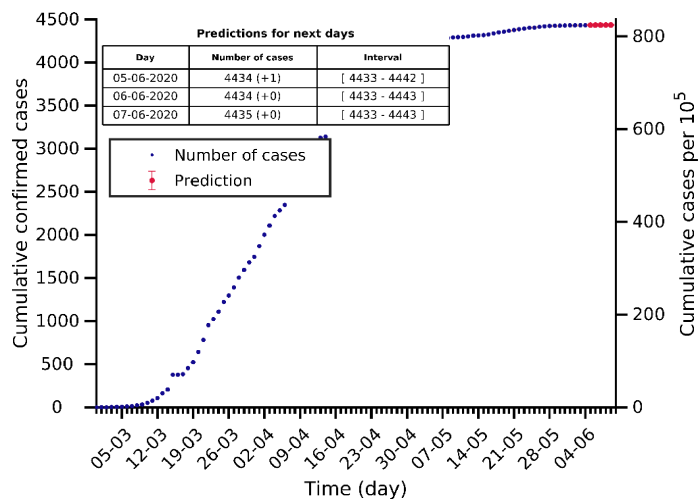
# Campania 04-06-2020. Population: 5.8M. Current cumulated incidence: 83/10<sup>5</sup>



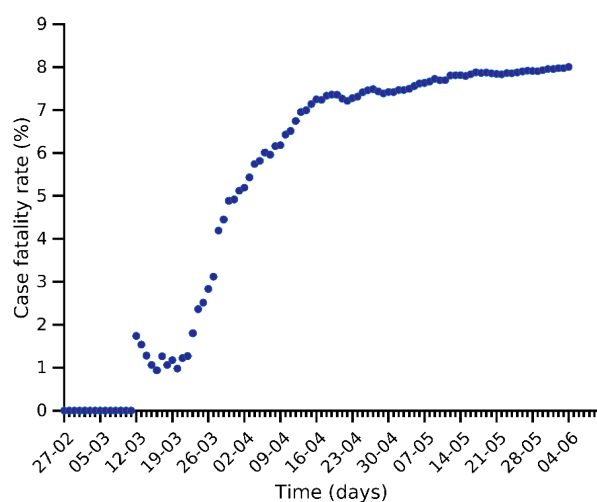
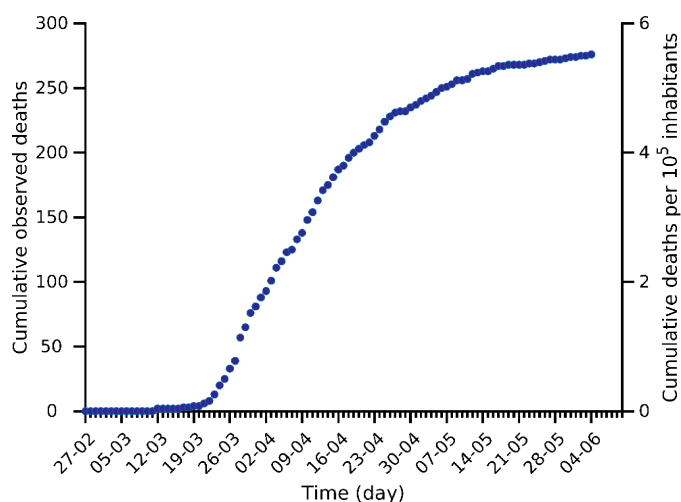
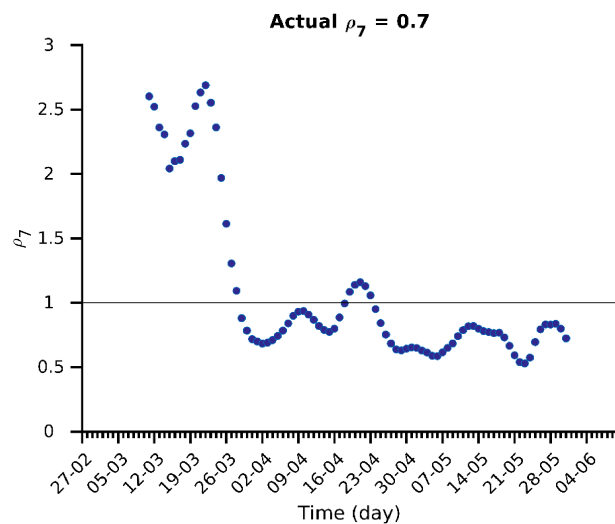
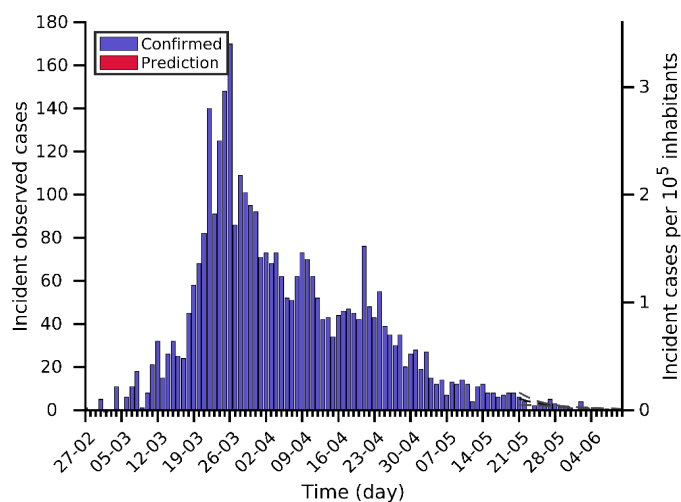
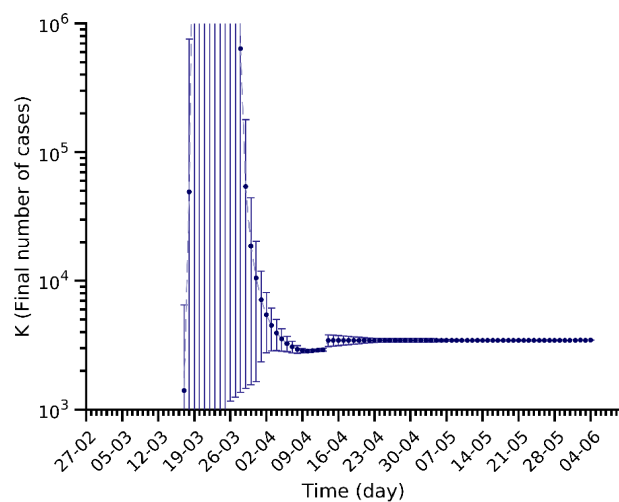
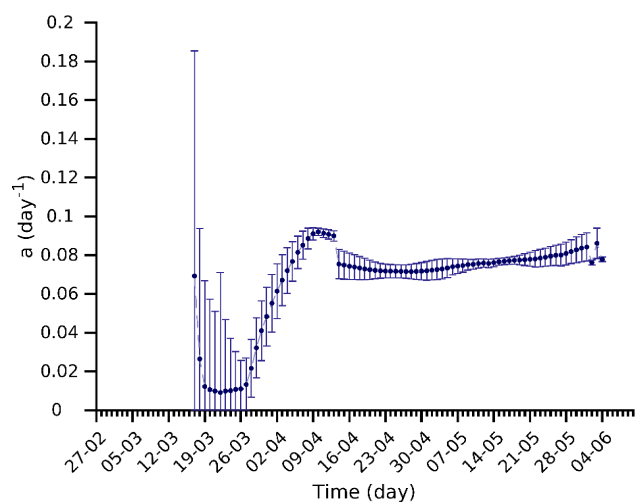
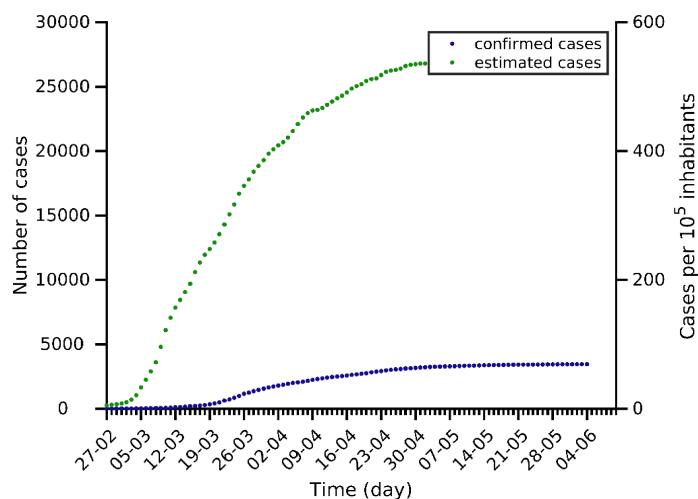
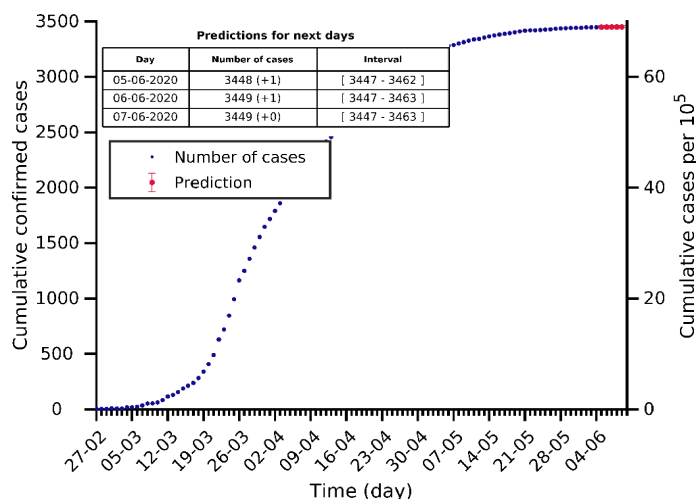
# Puglia 04-06-2020. Population: 4.0M. Current cumulated incidence: 112/10<sup>5</sup>



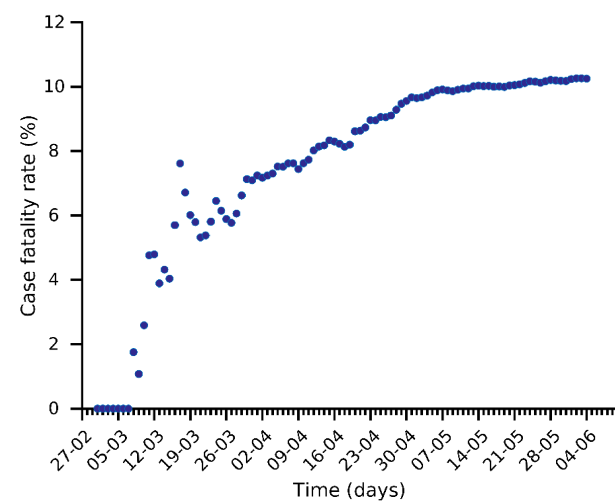
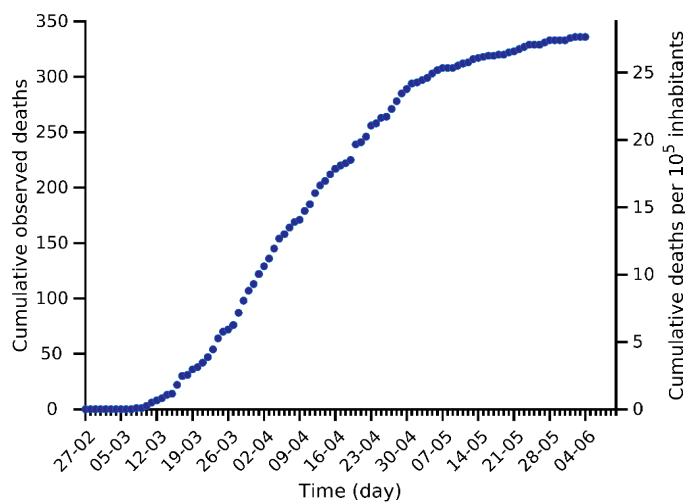
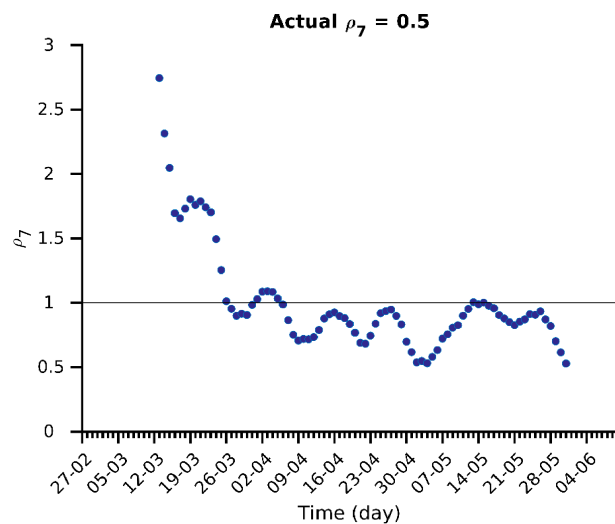
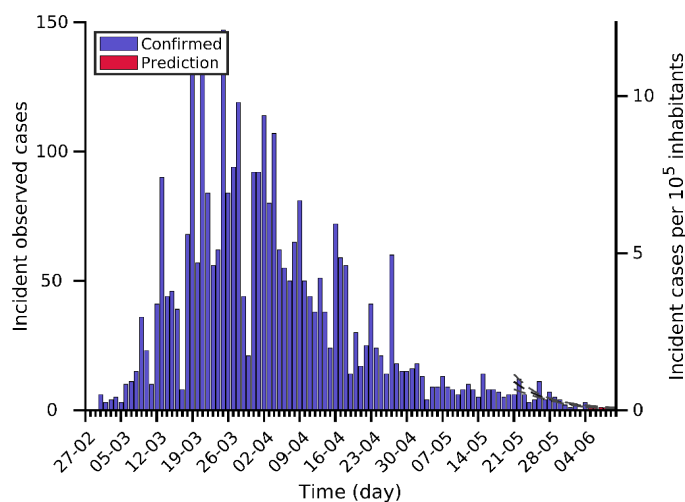
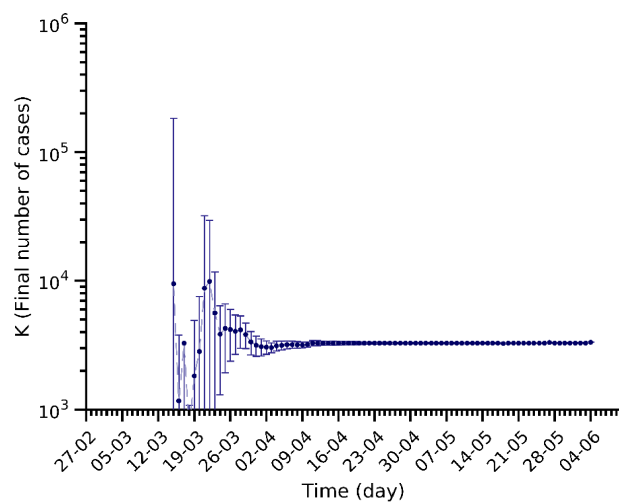
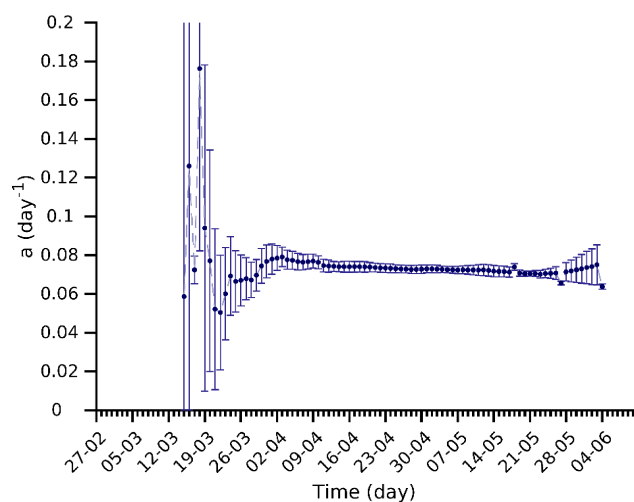
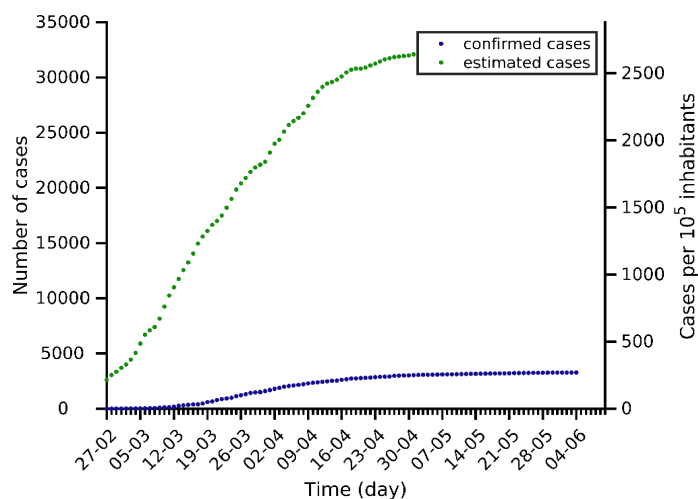
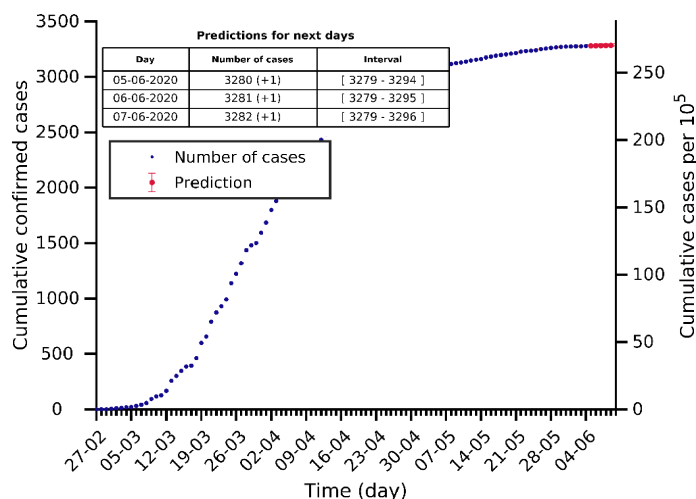
# Trento 04-06-2020. Population: 0.5M. Current cumulated incidence: 824/10<sup>5</sup>



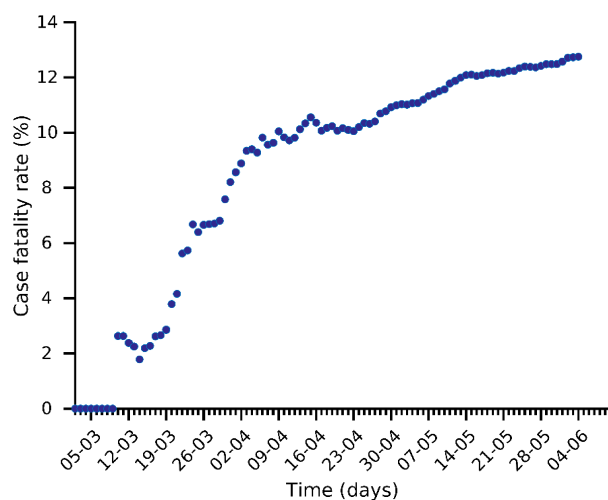
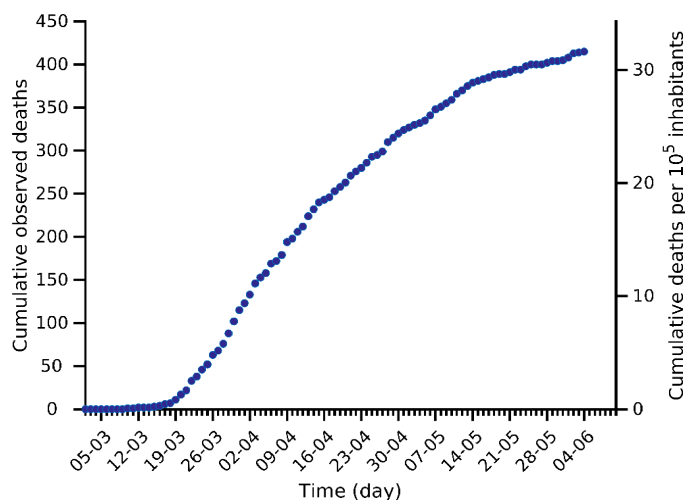
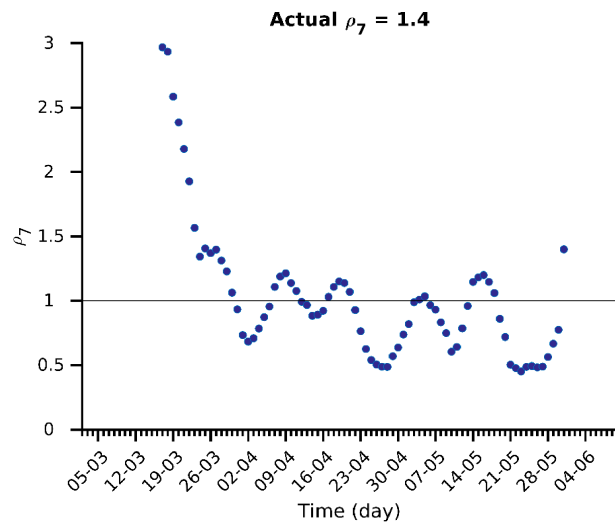
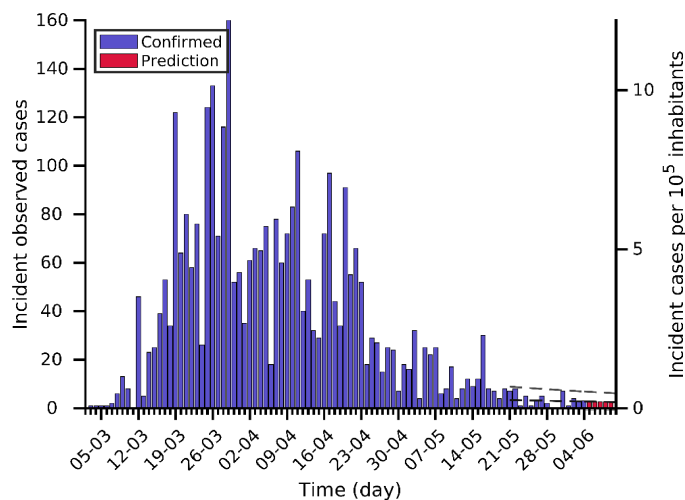
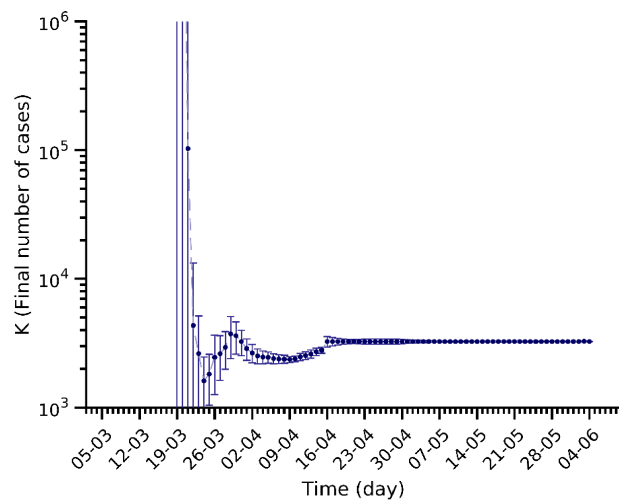
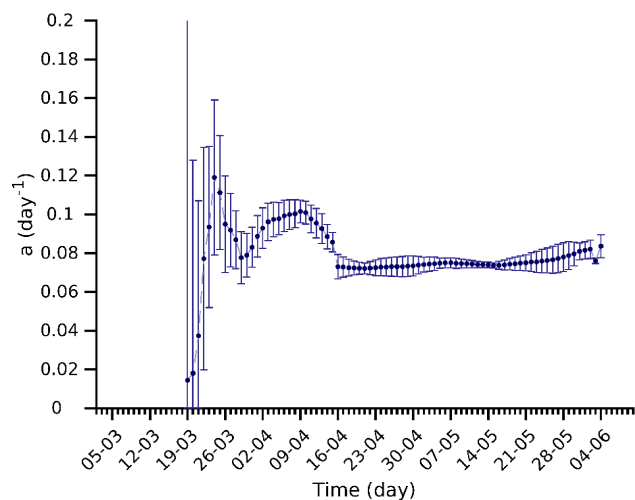
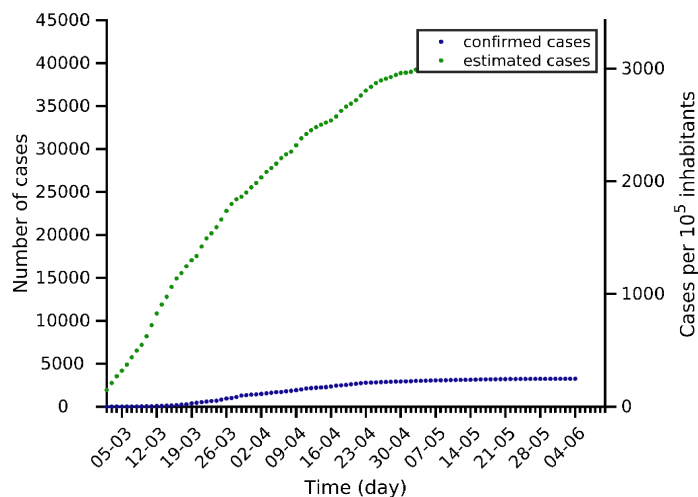
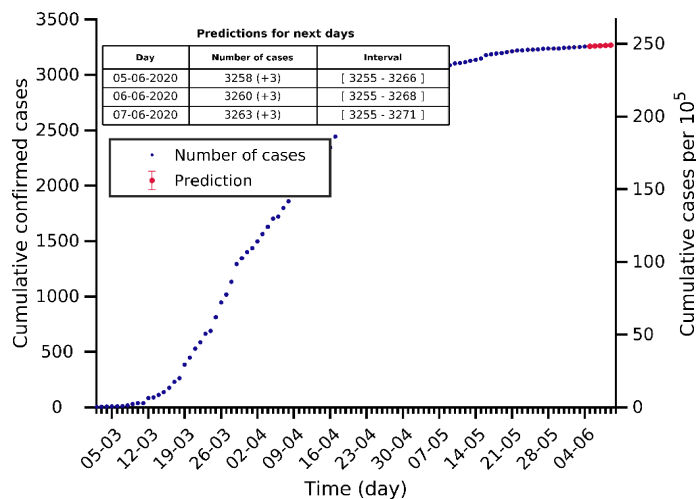
# Sicilia 04-06-2020. Population: 5.0M. Current cumulated incidence: 69/10<sup>5</sup>



# Friuli Venezia Giulia 04-06-2020. Population: 1.2M. Current cumulated incidence: 2

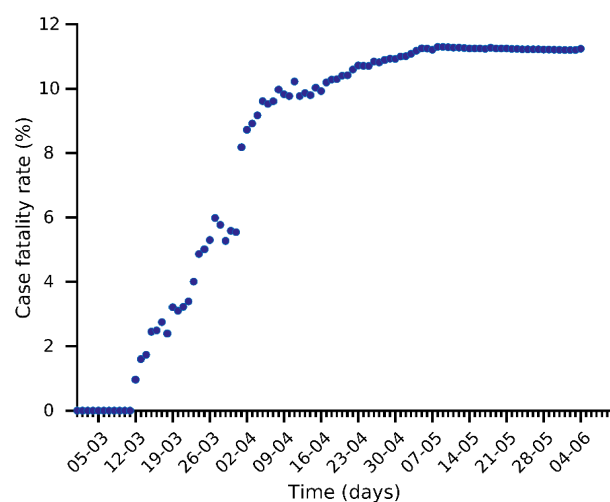
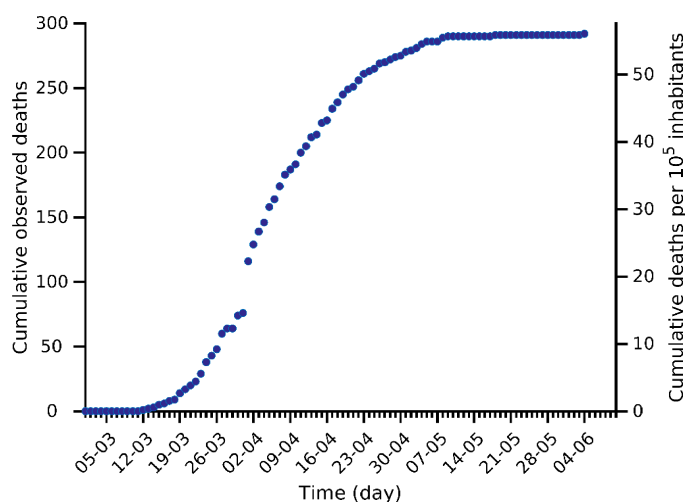
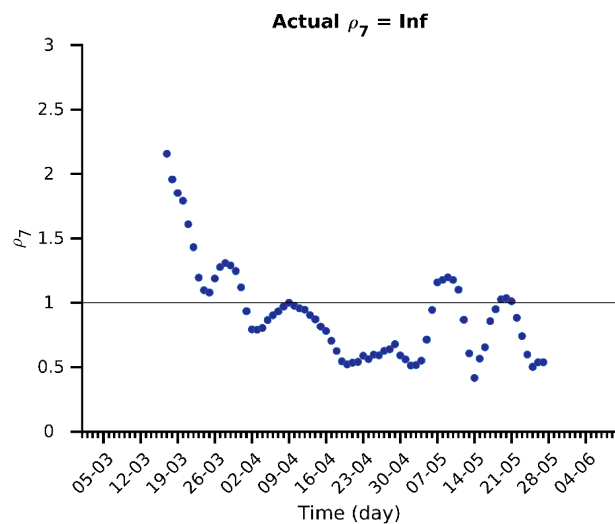
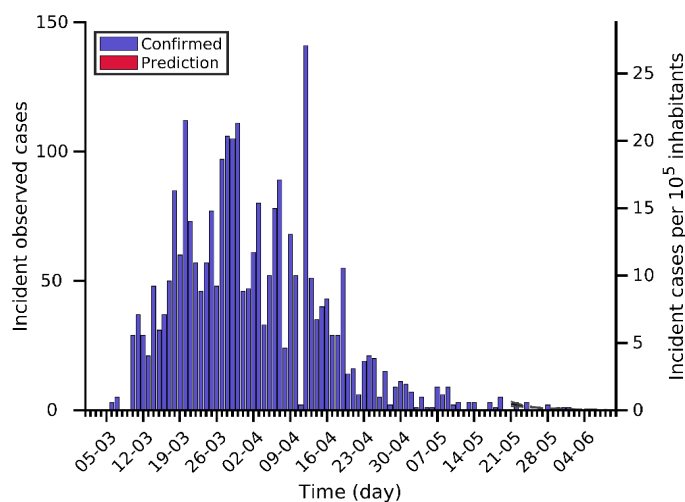
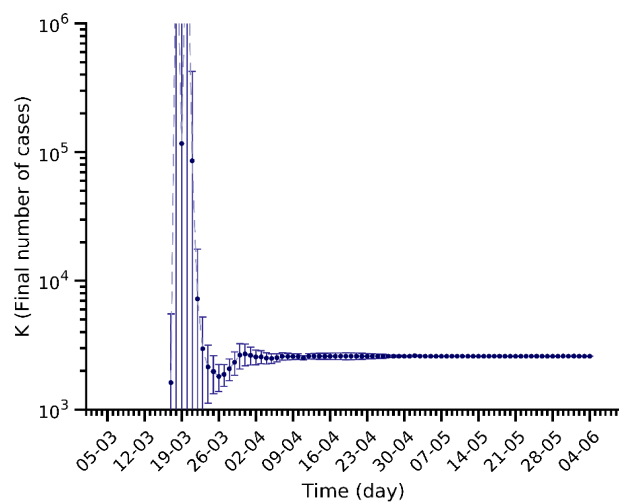
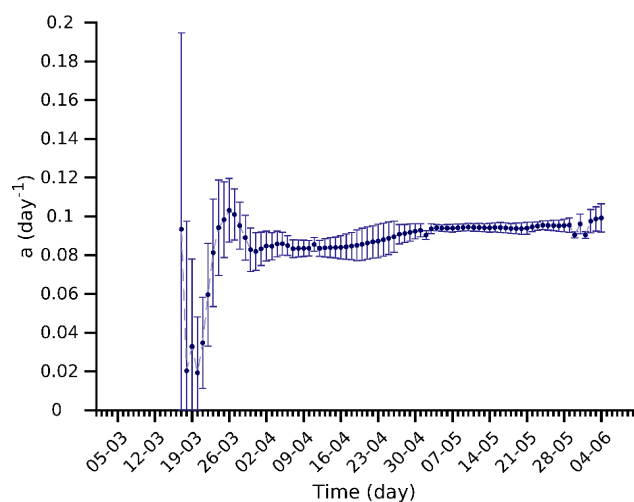
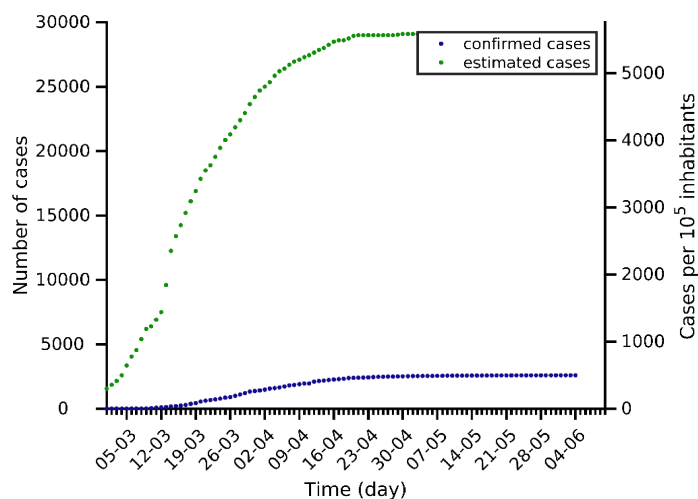
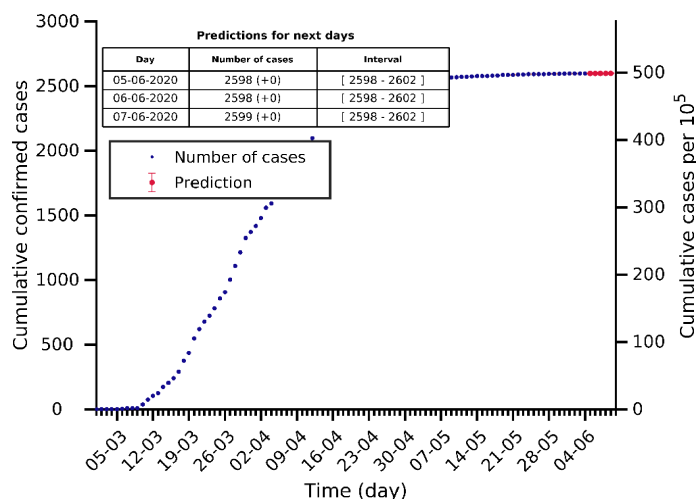


# Abruzzo 04-06-2020. Population: 1.3M. Current cumulated incidence: 248/10<sup>5</sup>

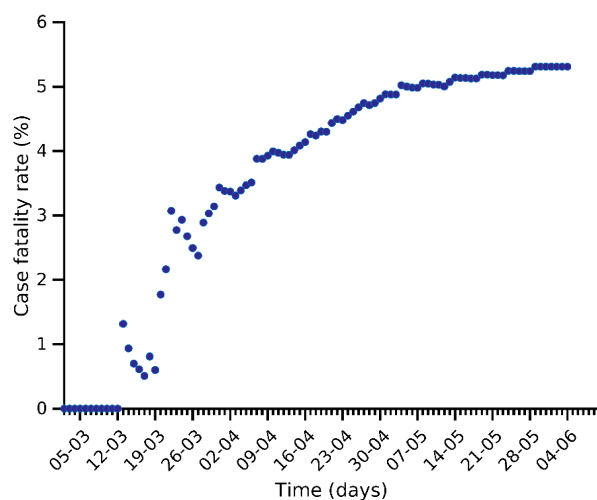
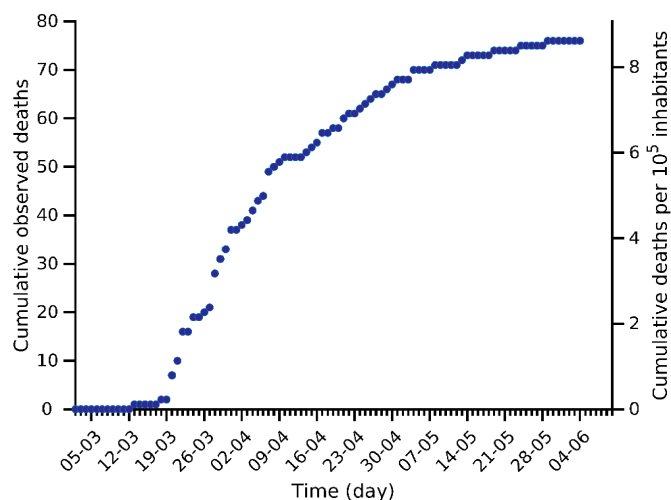
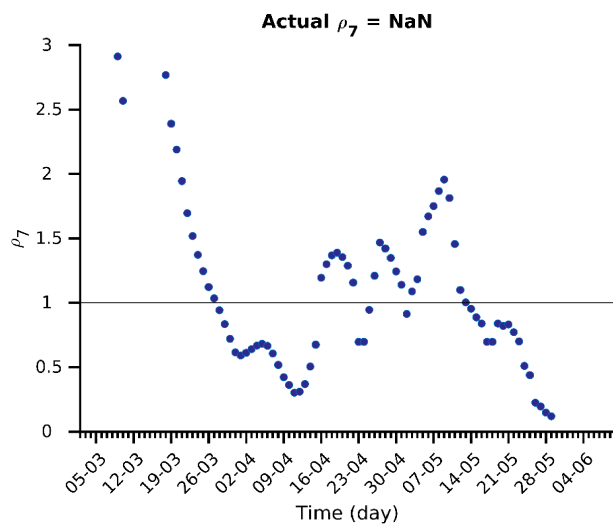
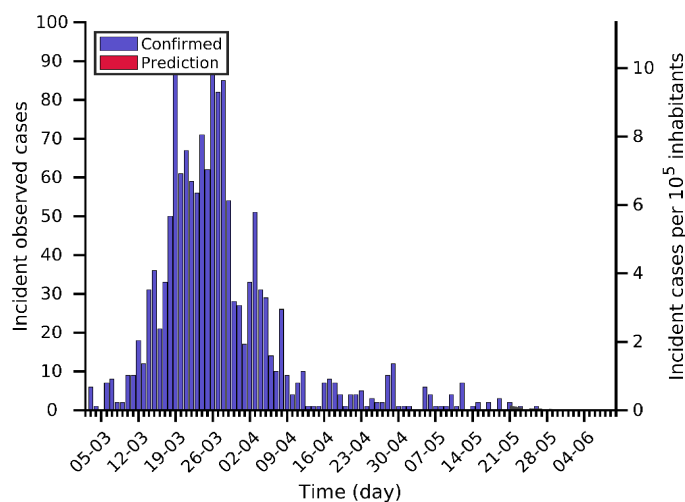
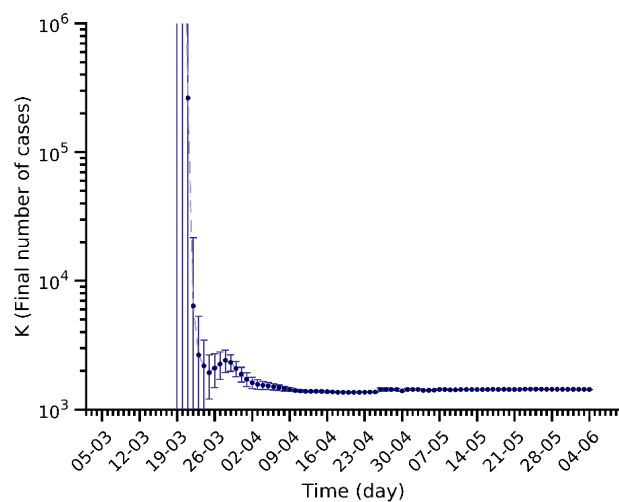
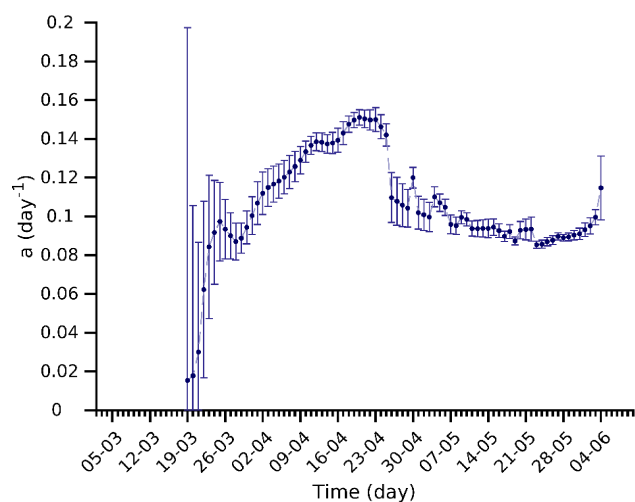
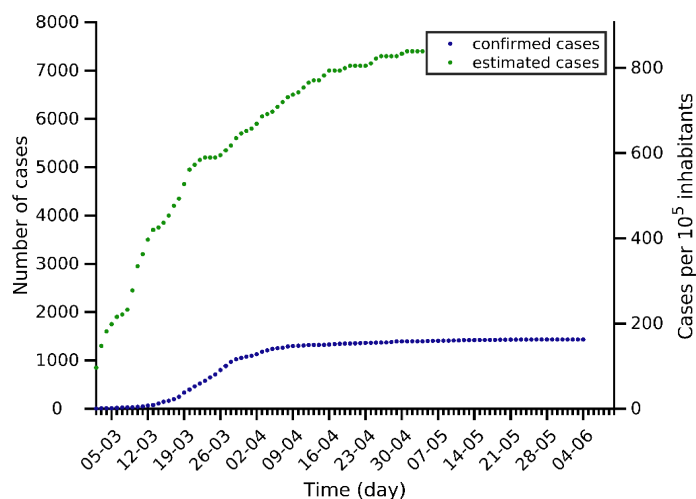
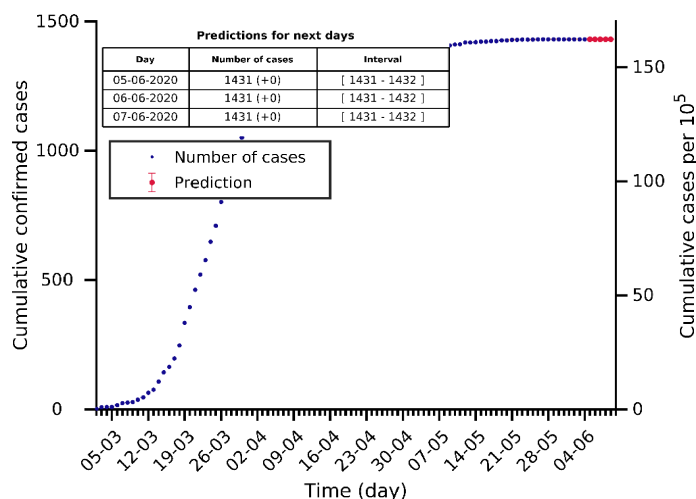




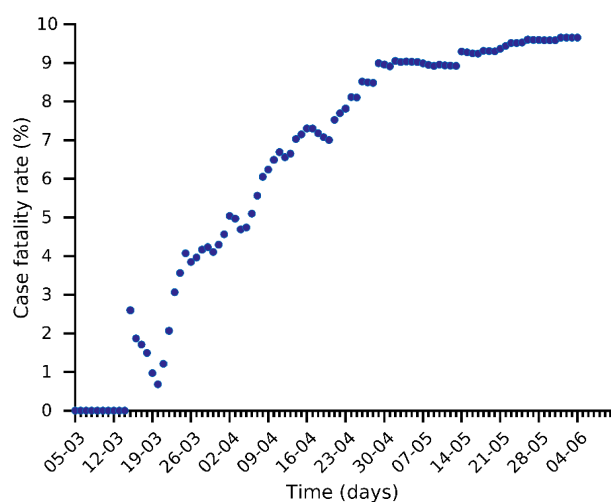
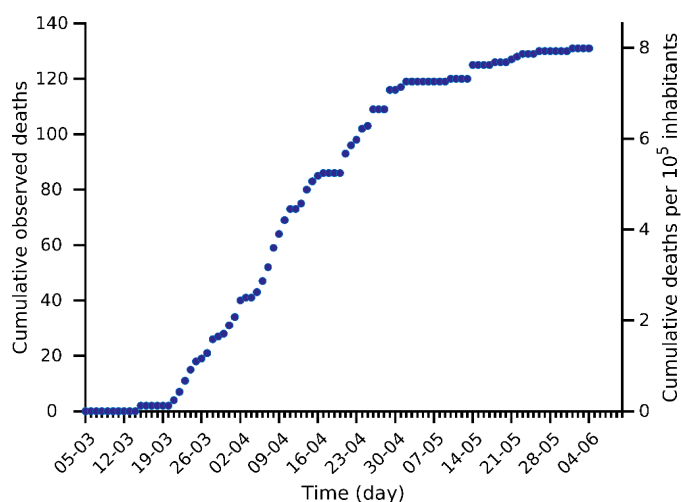
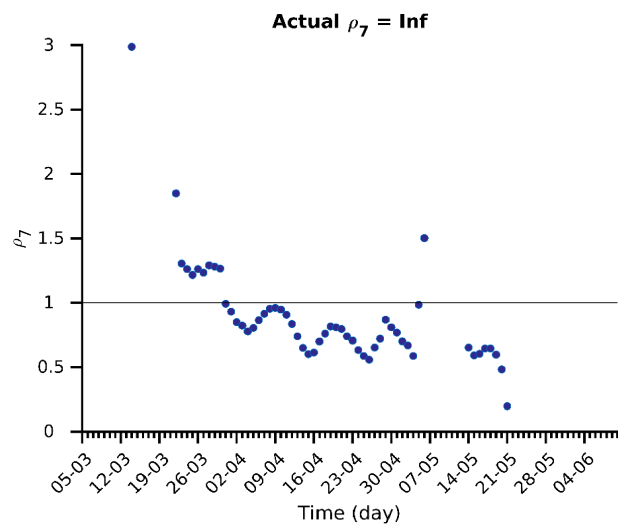
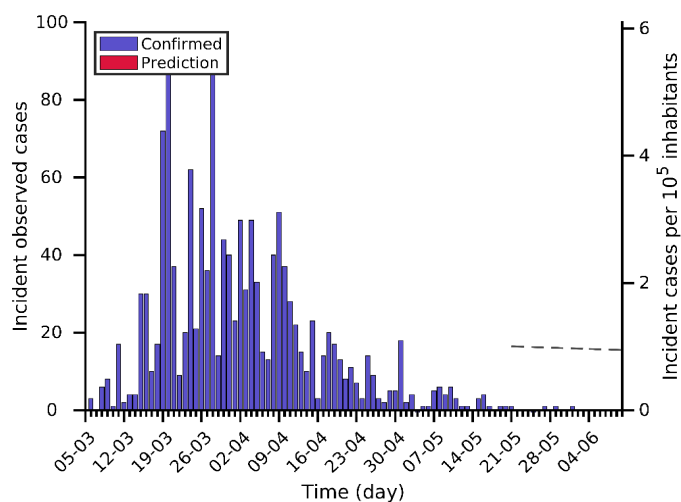
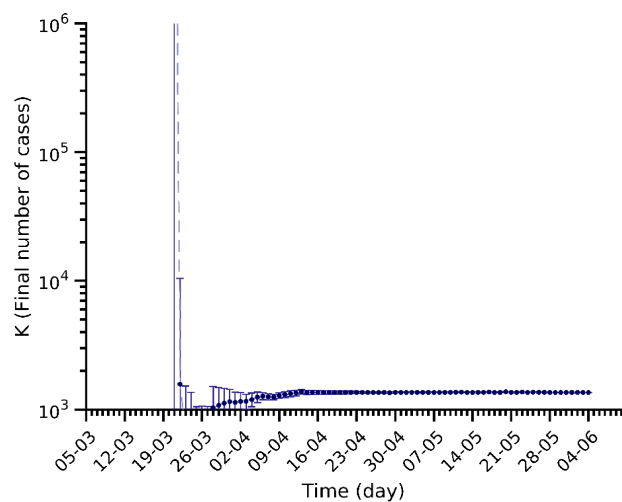
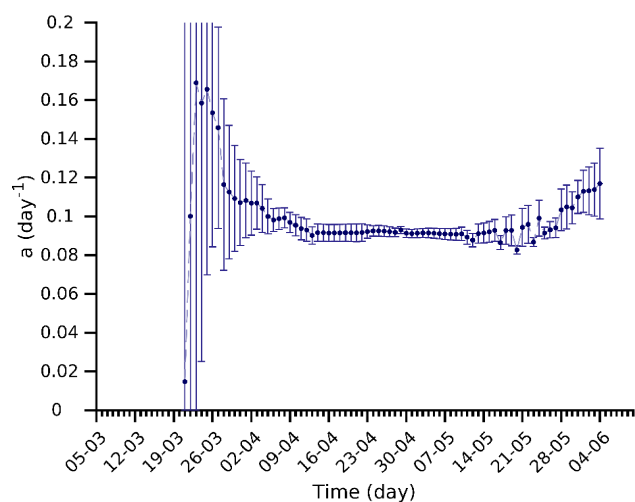
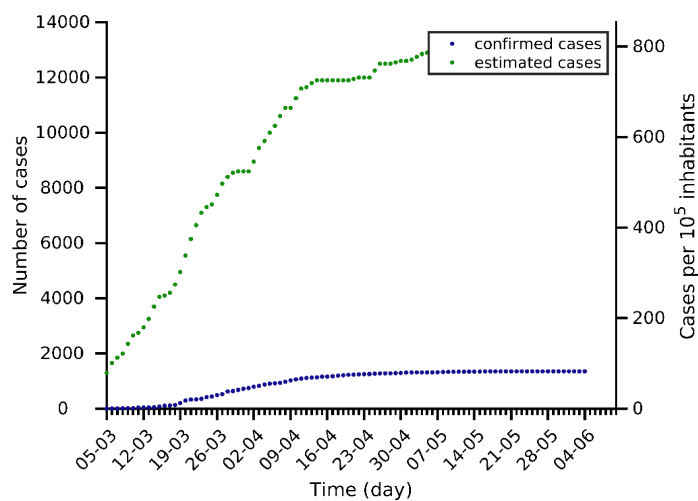
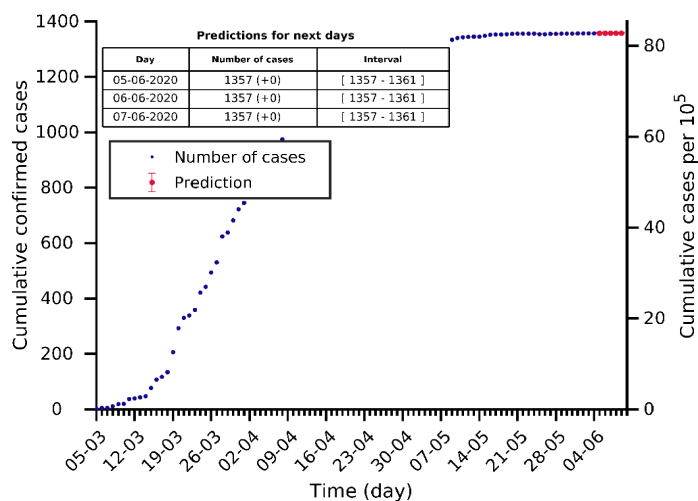
# Bolzano 04-06-2020. Population: 0.5M. Current cumulated incidence: 499/10<sup>5</sup>



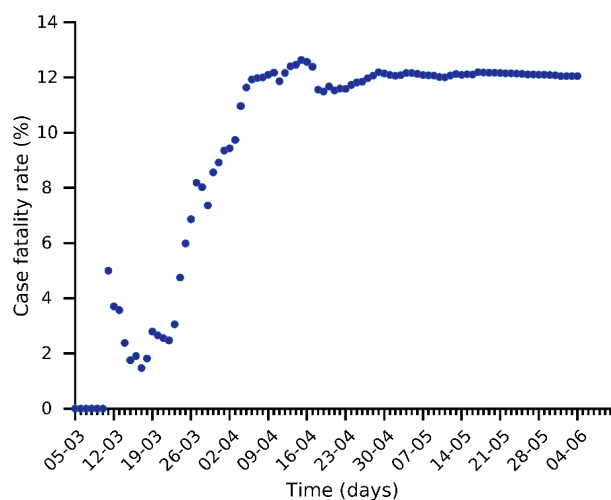
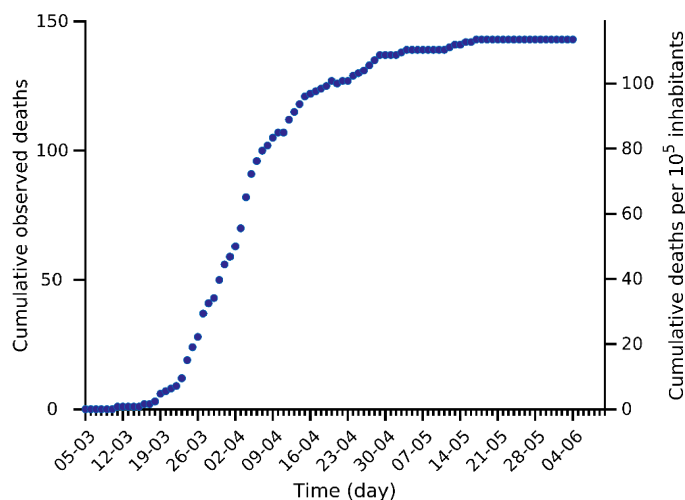
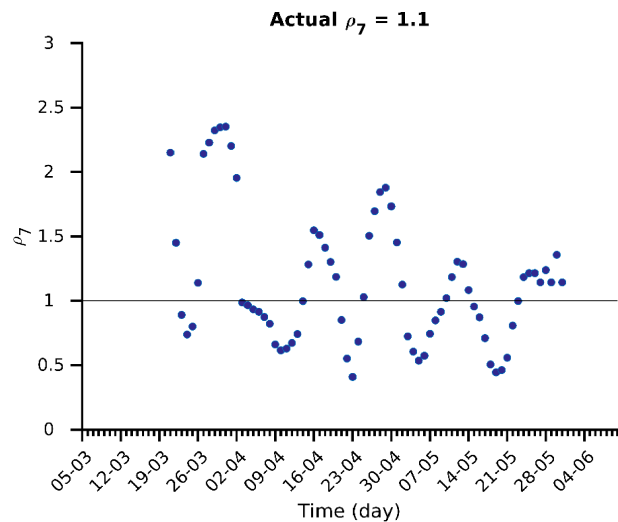
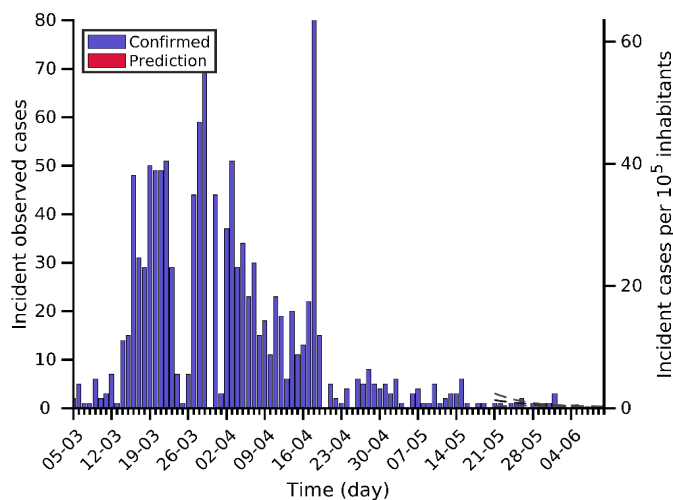
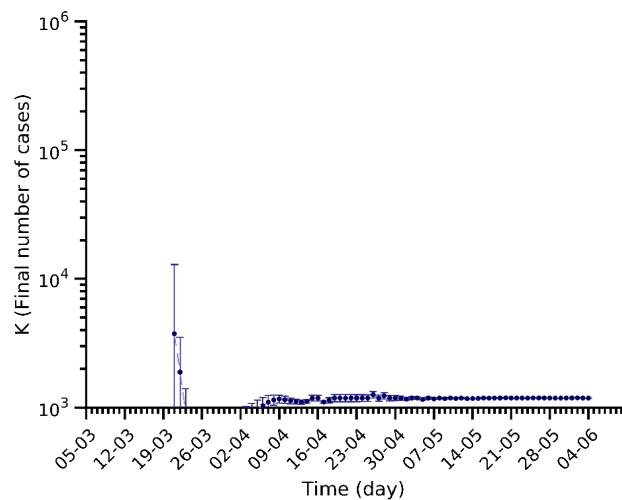
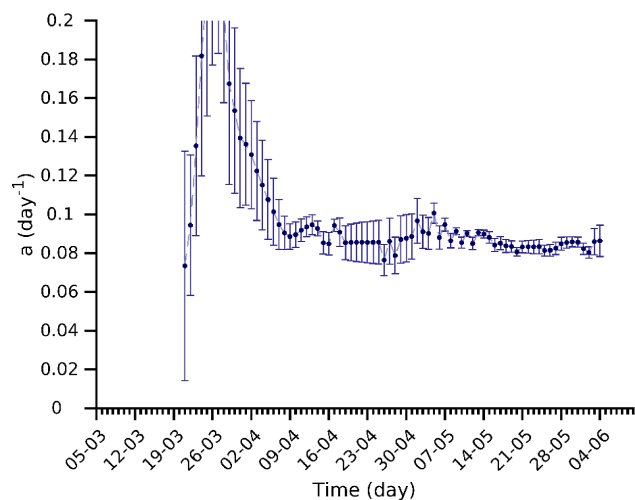
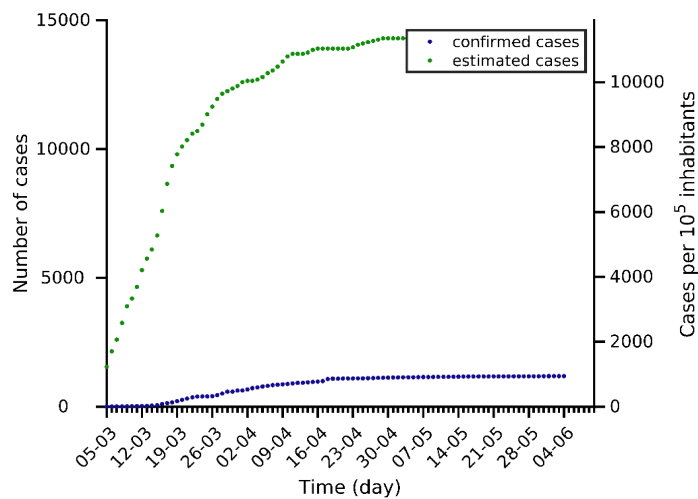
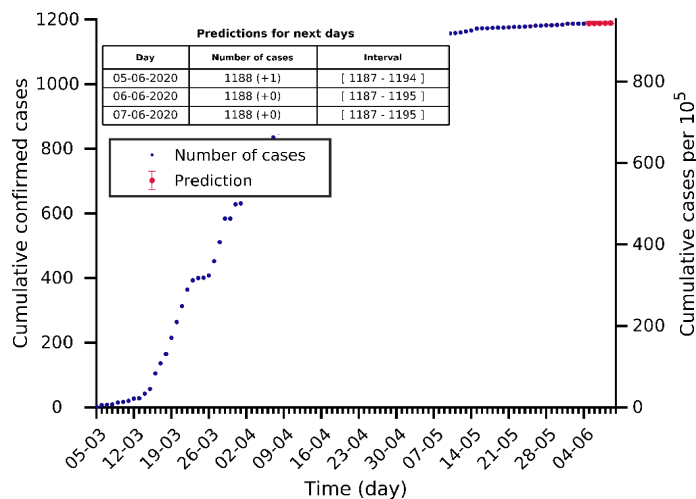
# Umbria 04-06-2020. Population: 0.9M. Current cumulated incidence: 162/10<sup>5</sup>



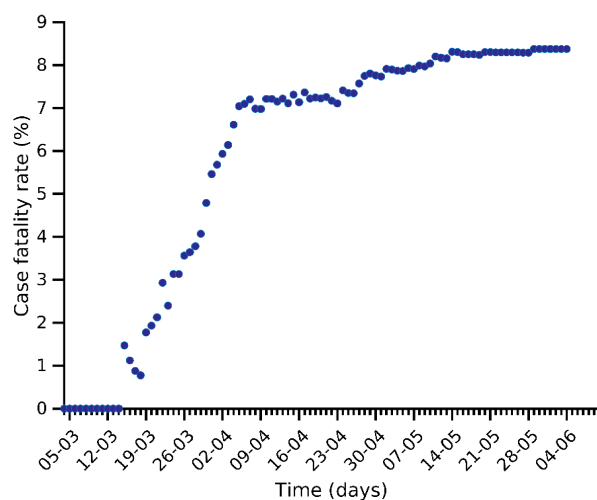
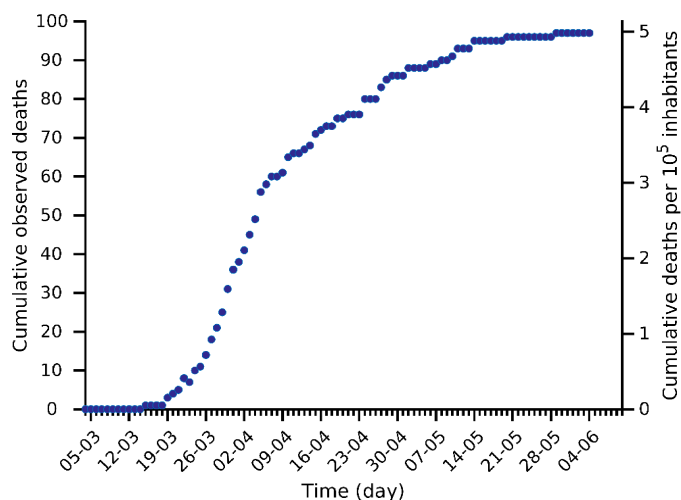
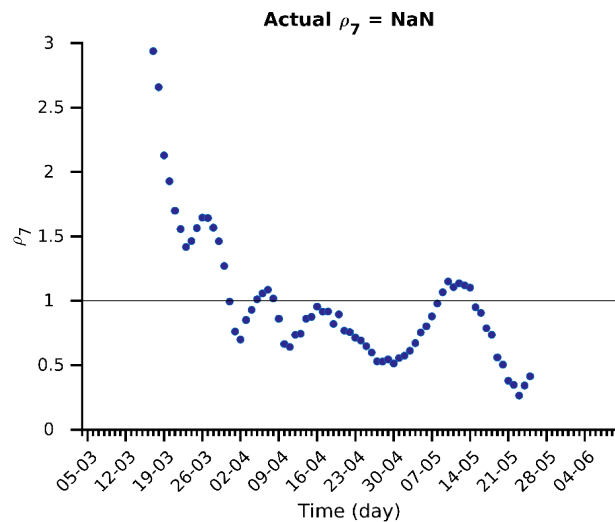
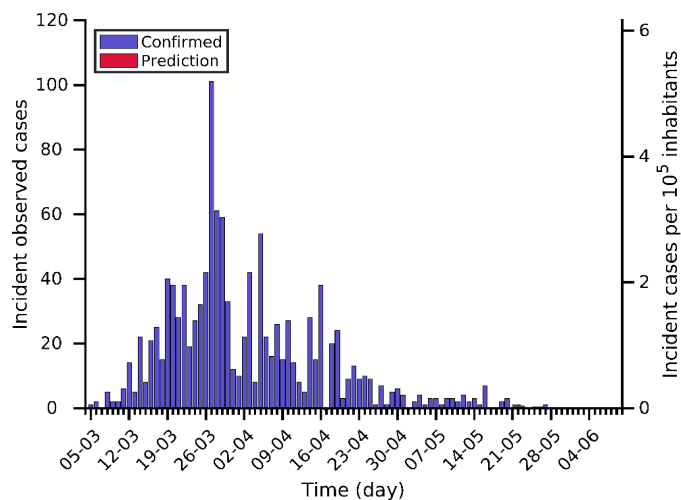
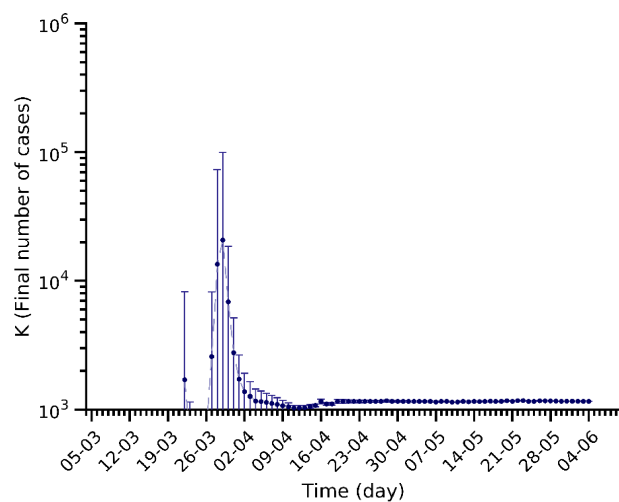
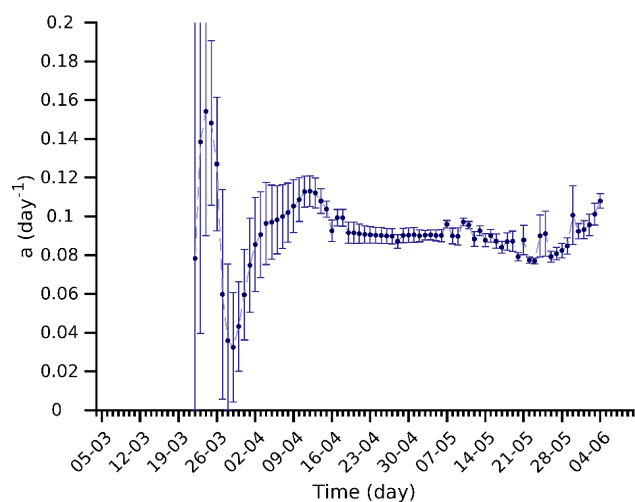
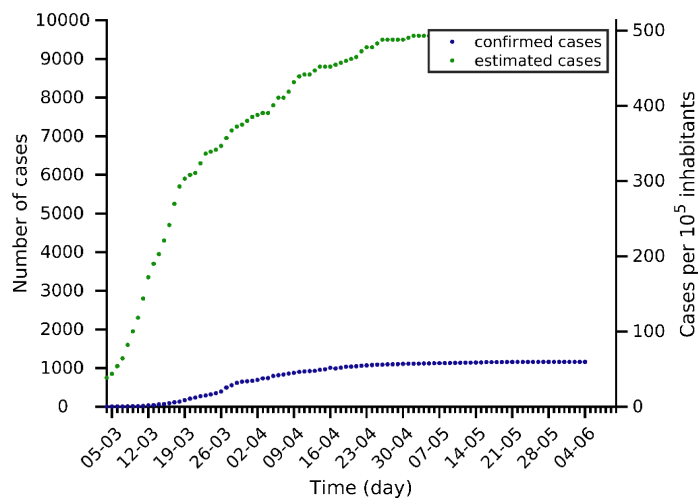
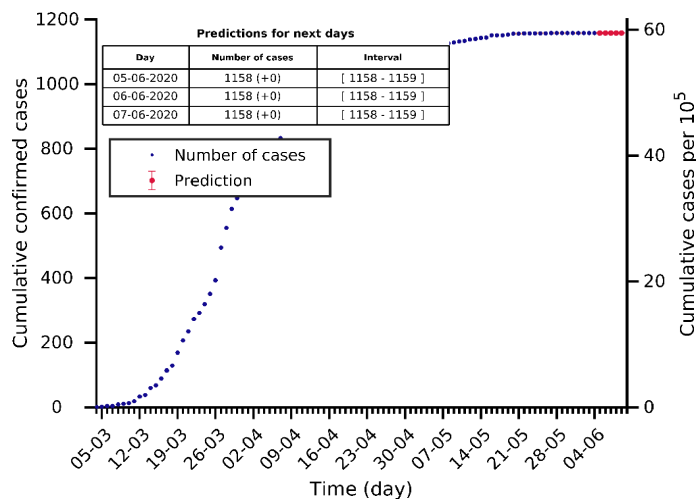
# Sardegna 04-06-2020. Population: 1.6M. Current cumulated incidence: 83/10<sup>5</sup>



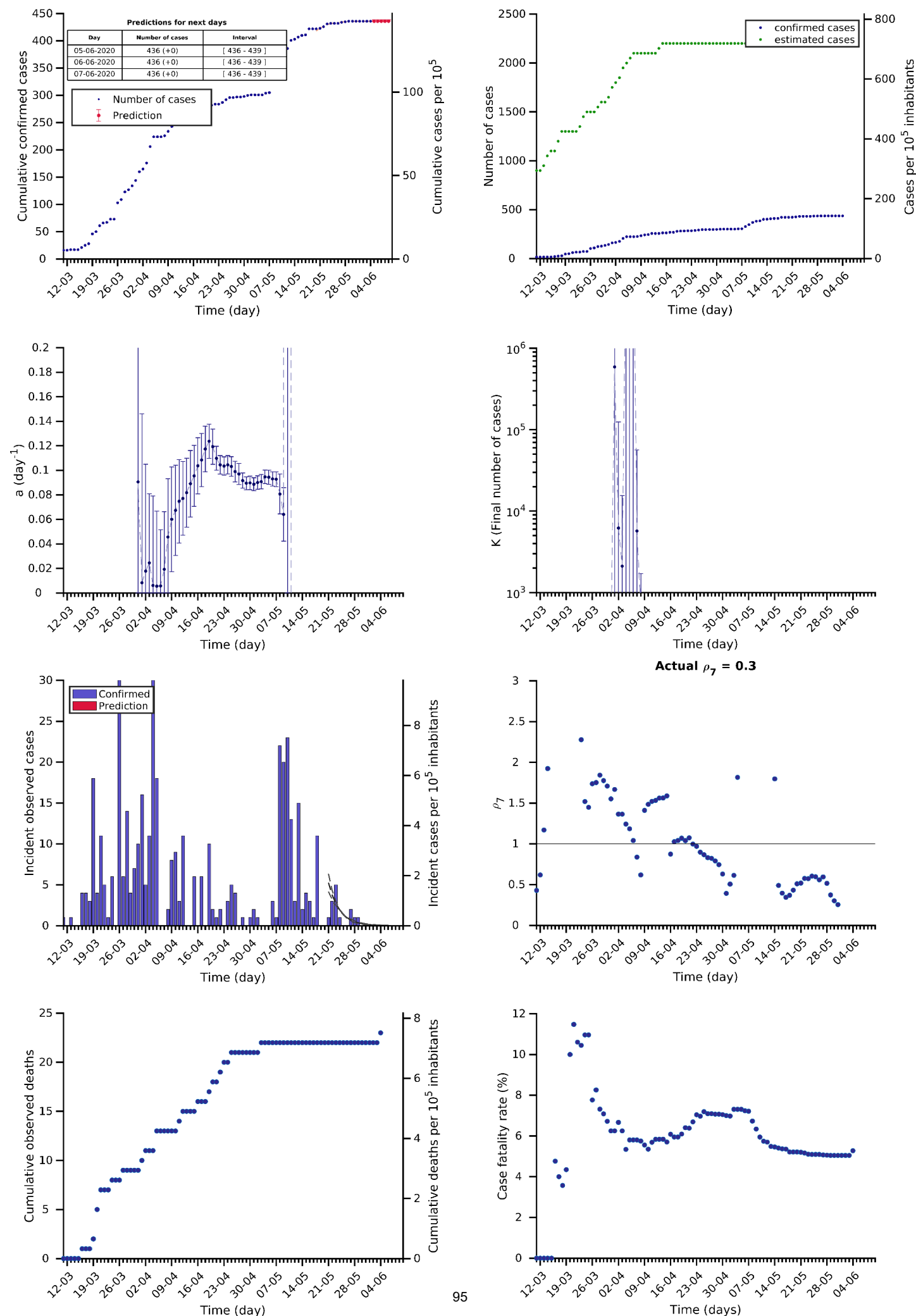
# Valle d'Aosta 04-06-2020. Population: 0.1M. Current cumulated incidence: 942/10<sup>5</sup>



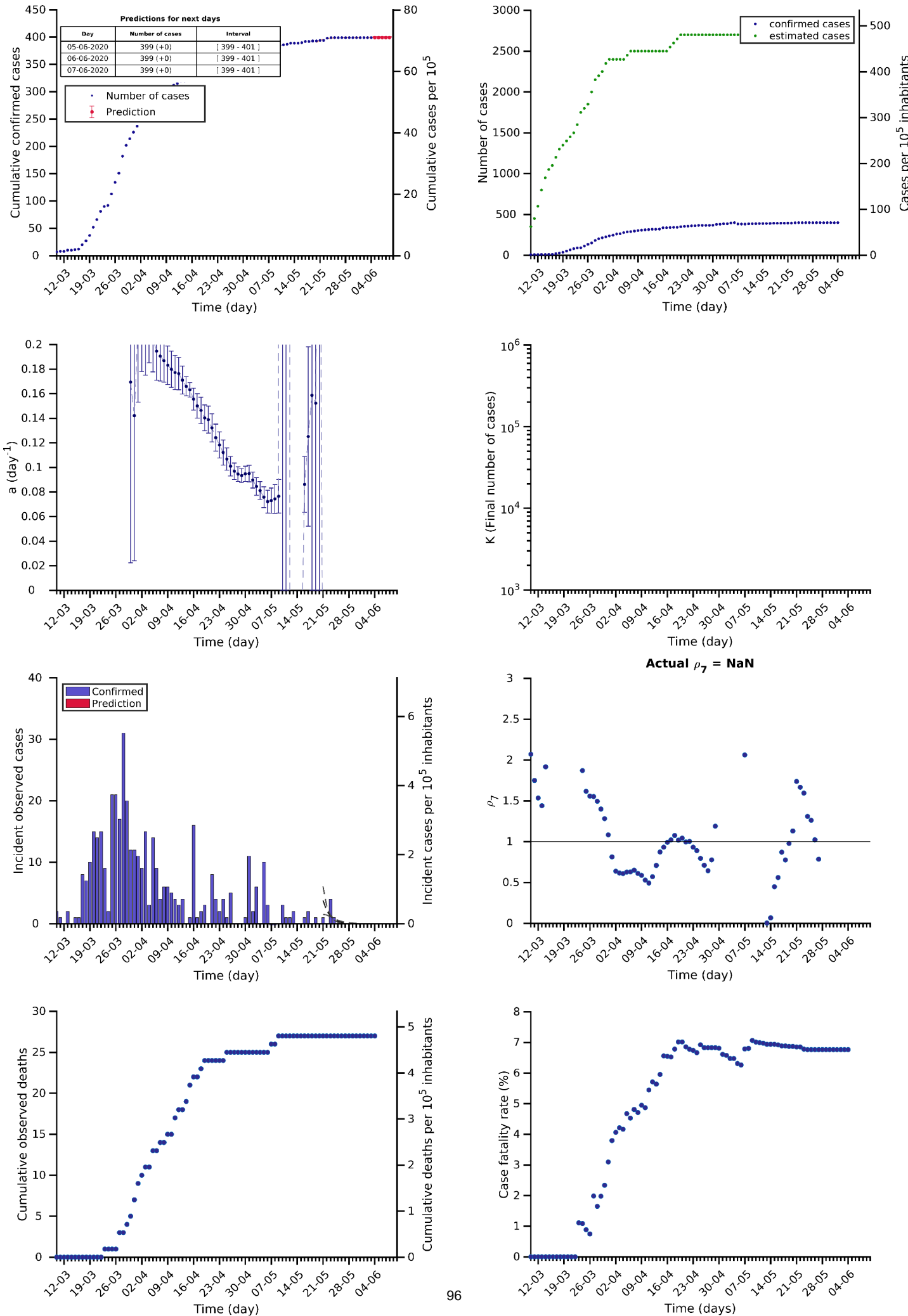
# Calabria 04-06-2020. Population: 1.9M. Current cumulated incidence: 59/10<sup>5</sup>



# Molise 04-06-2020. Population: 0.3M. Current cumulated incidence: 142/10<sup>5</sup>



Basilicata 04-06-2020. Population: 0.6M. Current cumulated incidence: 71/10<sup>5</sup>



## Methods



## Methods

### **(1) Data source**

Data are daily obtained from World Health Organization (WHO) surveillance reports<sup>4</sup>, from European Centre for Disease Prevention and Control (ECDC)<sup>5</sup> and from Ministerio de Sanidad<sup>6</sup>. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

### **(2) Data processing and plotting**

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓  $\rho$ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ( $t-1$ ):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where  $N_{new}(t)$  is the number of new confirmed cases at day  $t$ .

### **(3) Classification of countries according to their status in the epidemic cycle**

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

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<sup>4</sup> <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

<sup>5</sup> <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

<sup>6</sup> <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>  
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

#### ***(4) Fitting a mathematical model to data***

Previous studies have shown that Gompertz model<sup>7</sup> correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where  $N(t)$  is the cumulated number of confirmed cases at  $t$  (in days), and  $N_0$  is the number of cumulated cases the day at day  $t_0$ . The model has two parameters:

- ✓  $a$  is the velocity at which specific spreading rate is slowing down;
- ✓  $K$  is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day  $t_0$  is chosen as that one at which  $N(t)$  overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters ( $a$  and  $K$ ) and the  $R^2$  of the fitting. At the initial stages the dynamics is exponential and  $K$  cannot be correctly evaluated. In fact, at this stage the most relevant parameter is  $a$ . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted  $a$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted  $K$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if  $a > 0.2 \text{ day}^{-1}$ , if  $K > 10^6$  or if the error in  $K$  overpasses  $10^6$ .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

#### ***(5) Using the model for predicting short-term tendencies***

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

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<sup>7</sup> Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days<sup>8</sup>;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

### ***(6) Estimating non-diagnosed cases***

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors<sup>9</sup> in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

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<sup>8</sup> At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

<sup>9</sup> Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3